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Friedman et al.

(10) **Patent No.: US 8,506,108 B2**
(45) **Date of Patent: Aug. 13, 2013**

(54) **POWER TOOL WITH LIGHT FOR ILLUMINATING A WORKPIECE**

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(73) Assignee: **Black & Decker Inc.**, Newark, DE (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/616,610**

(22) Filed: **Sep. 14, 2012**

(65) **Prior Publication Data**

US 2013/0003358 A1 Jan. 3, 2013

Related U.S. Application Data

(63) Continuation of application No. 12/895,051, filed on Sep. 30, 2010, now Pat. No. 8,317,350, which is a continuation-in-part of application No. 12/379,585, filed on Feb. 25, 2009, now Pat. No. 8,328,381, and a continuation-in-part of application No. 12/859,036, filed on Aug. 18, 2010.

(51) **Int. Cl.**
B25B 23/18 (2006.01)

(52) **U.S. Cl.**
USPC **362/119**; 362/192

(58) **Field of Classification Search**
USPC 362/109, 119, 120, 192, 193
See application file for complete search history.

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Primary Examiner — Y My Quach Lee
(74) *Attorney, Agent, or Firm* — Scott B. Markow

(57) **ABSTRACT**

A power tool having a light for illuminating an area proximate a movable end effector. The light may be mounted in such a way as to transmit light through a rotatable collar on the power tool, through or through a member of a housing of the power tool, or from the moving end effector. The light may be powered by a power source that is used for moving the end effector or from a generator that generates electrical power when the power tool is used.

20 Claims, 29 Drawing Sheets

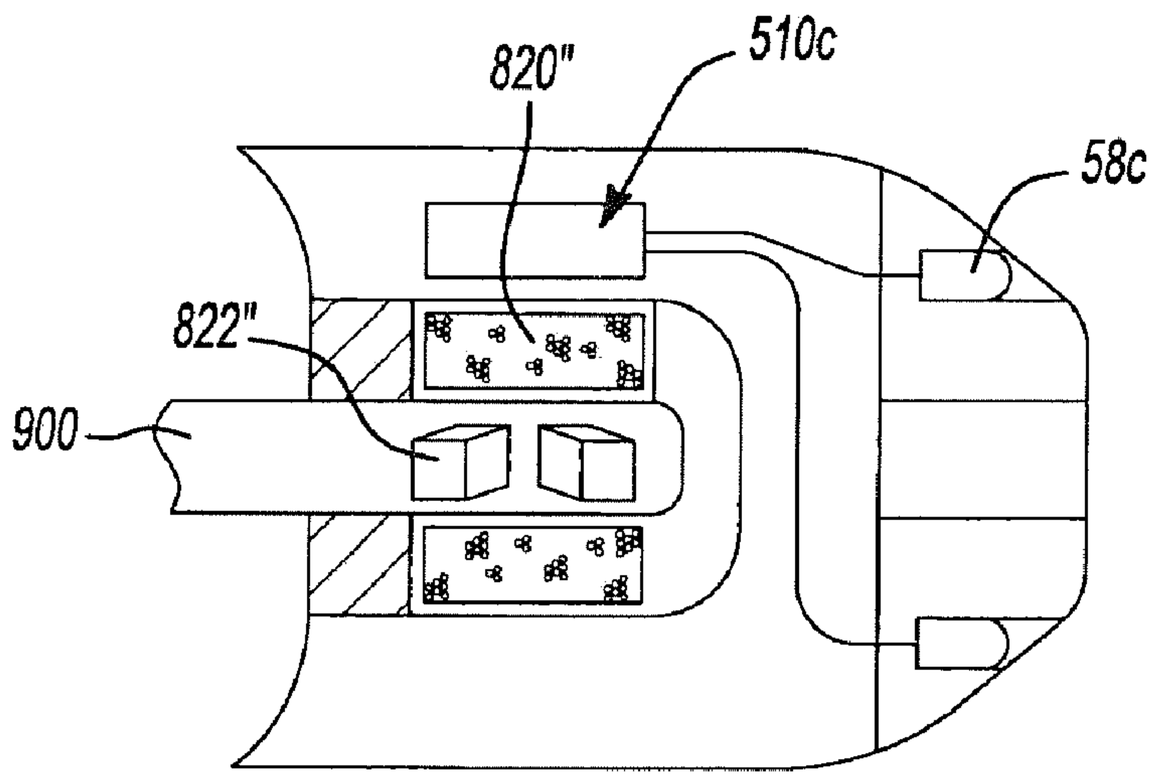

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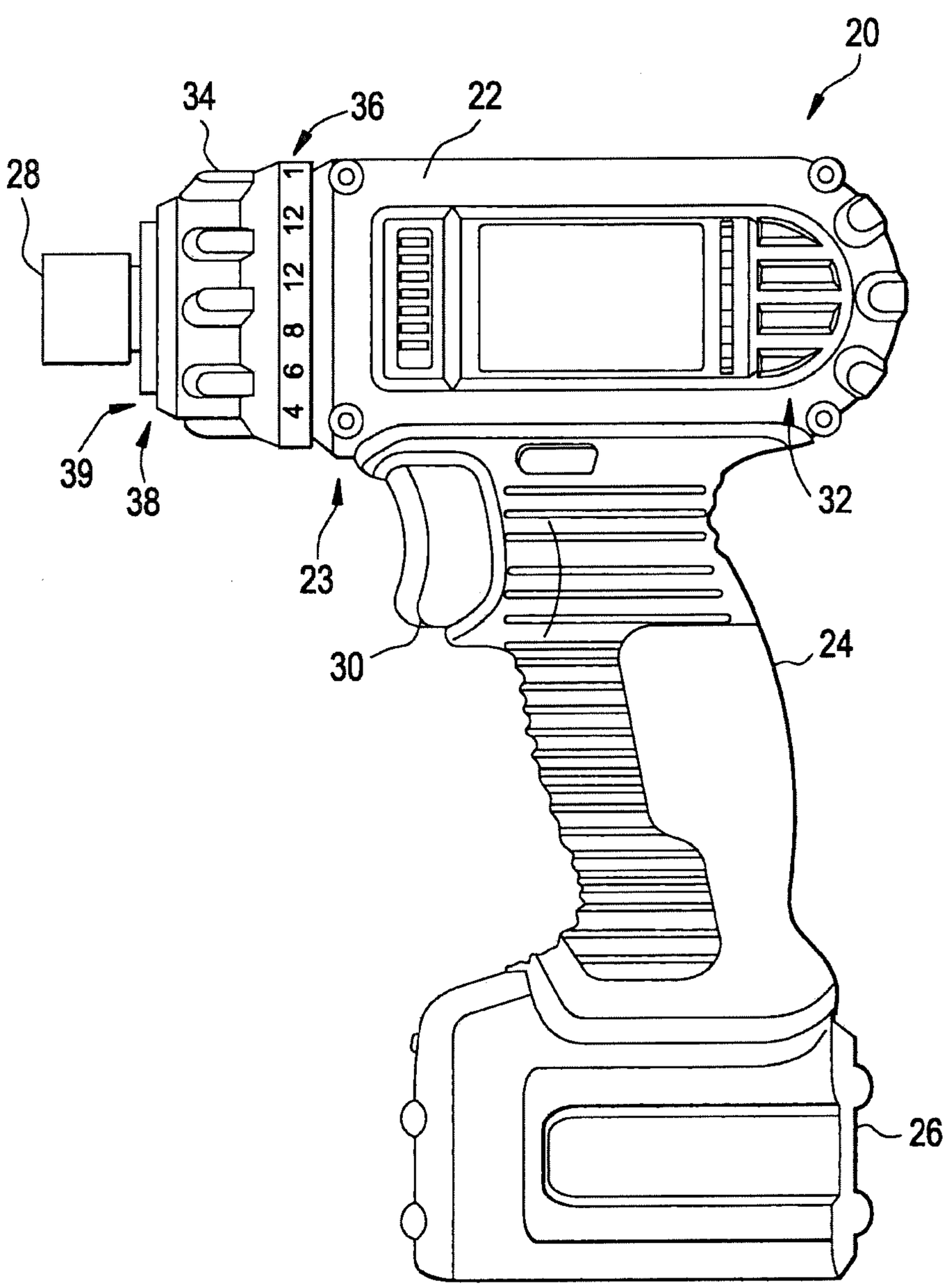
FIG. 1



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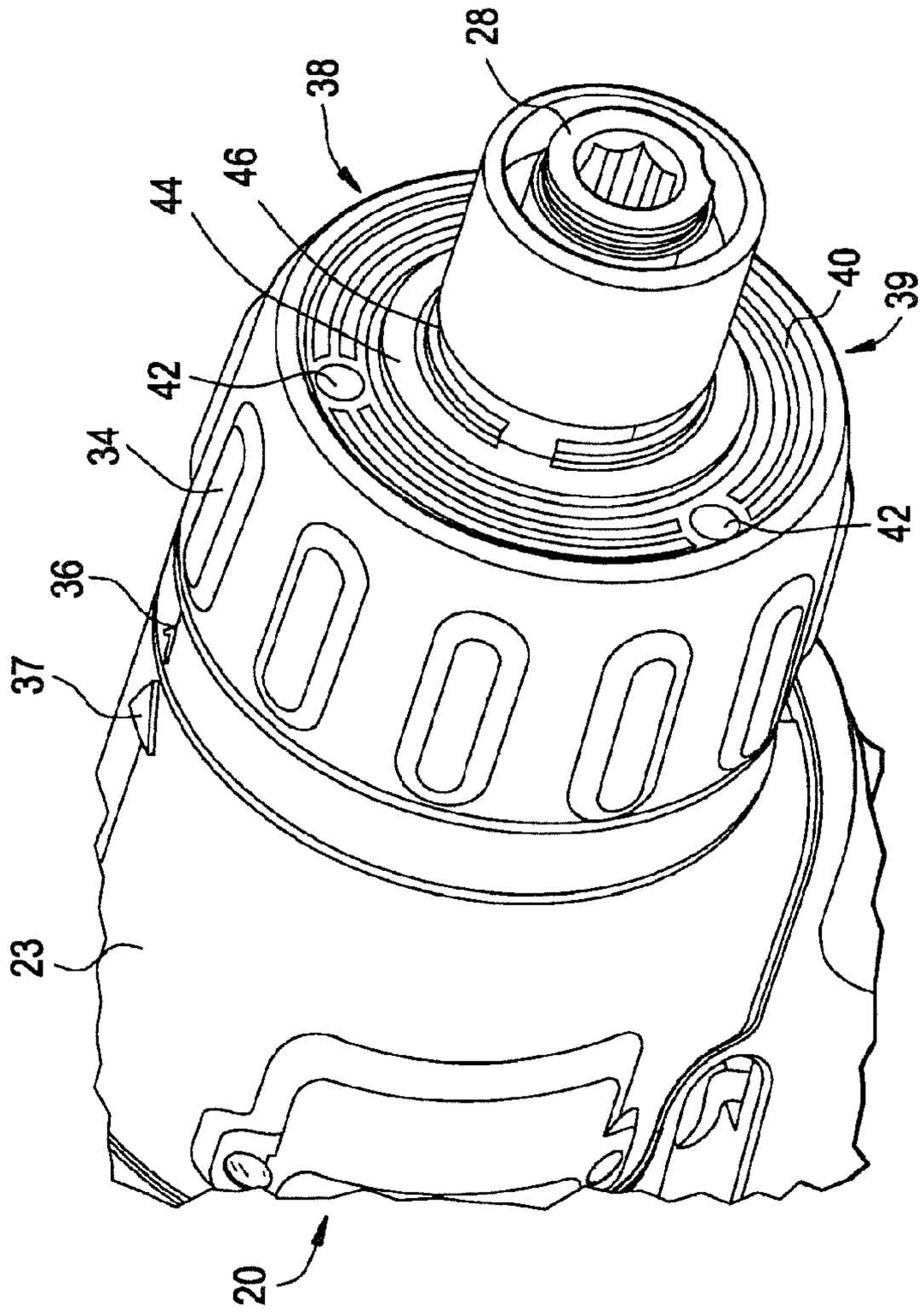

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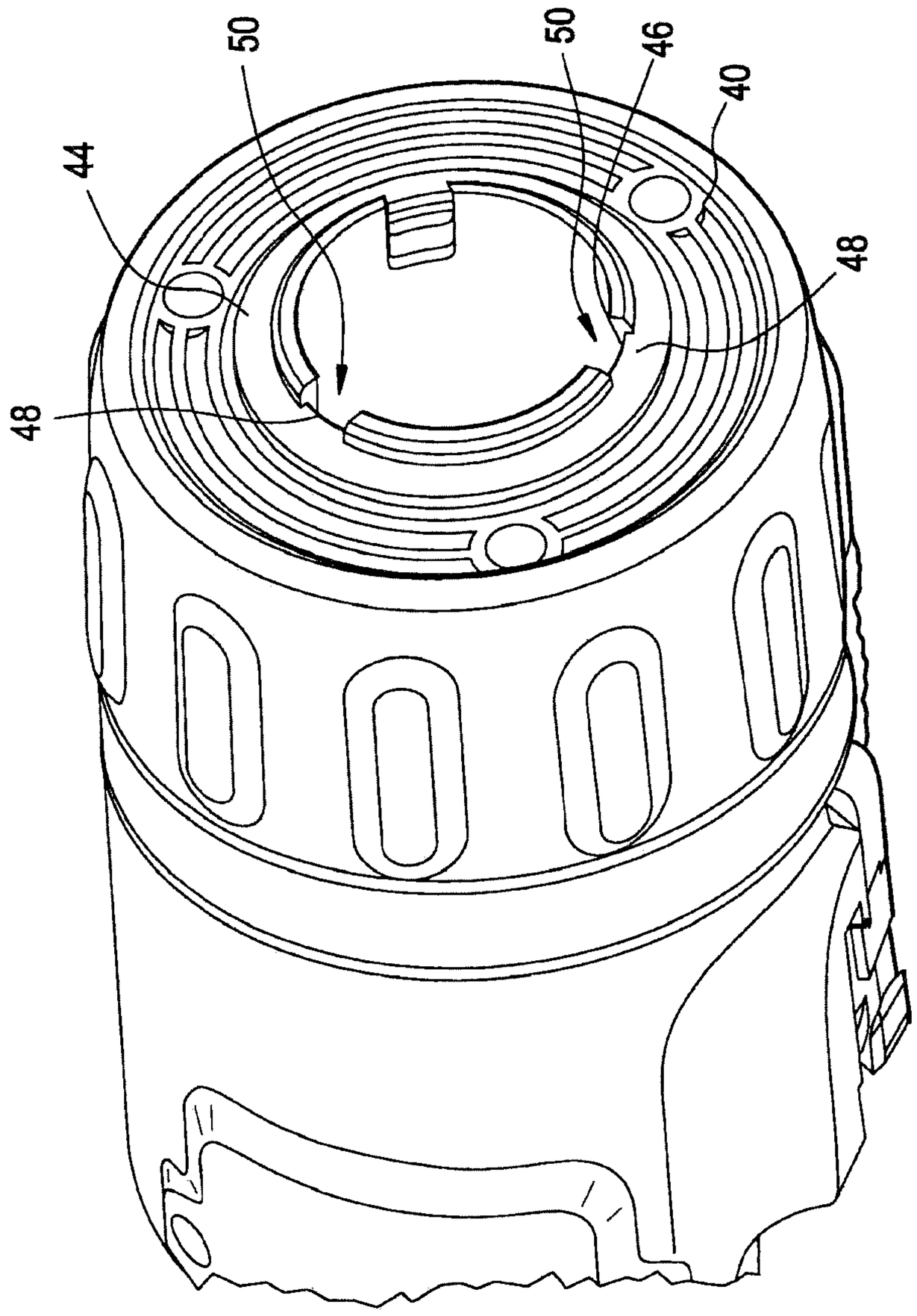

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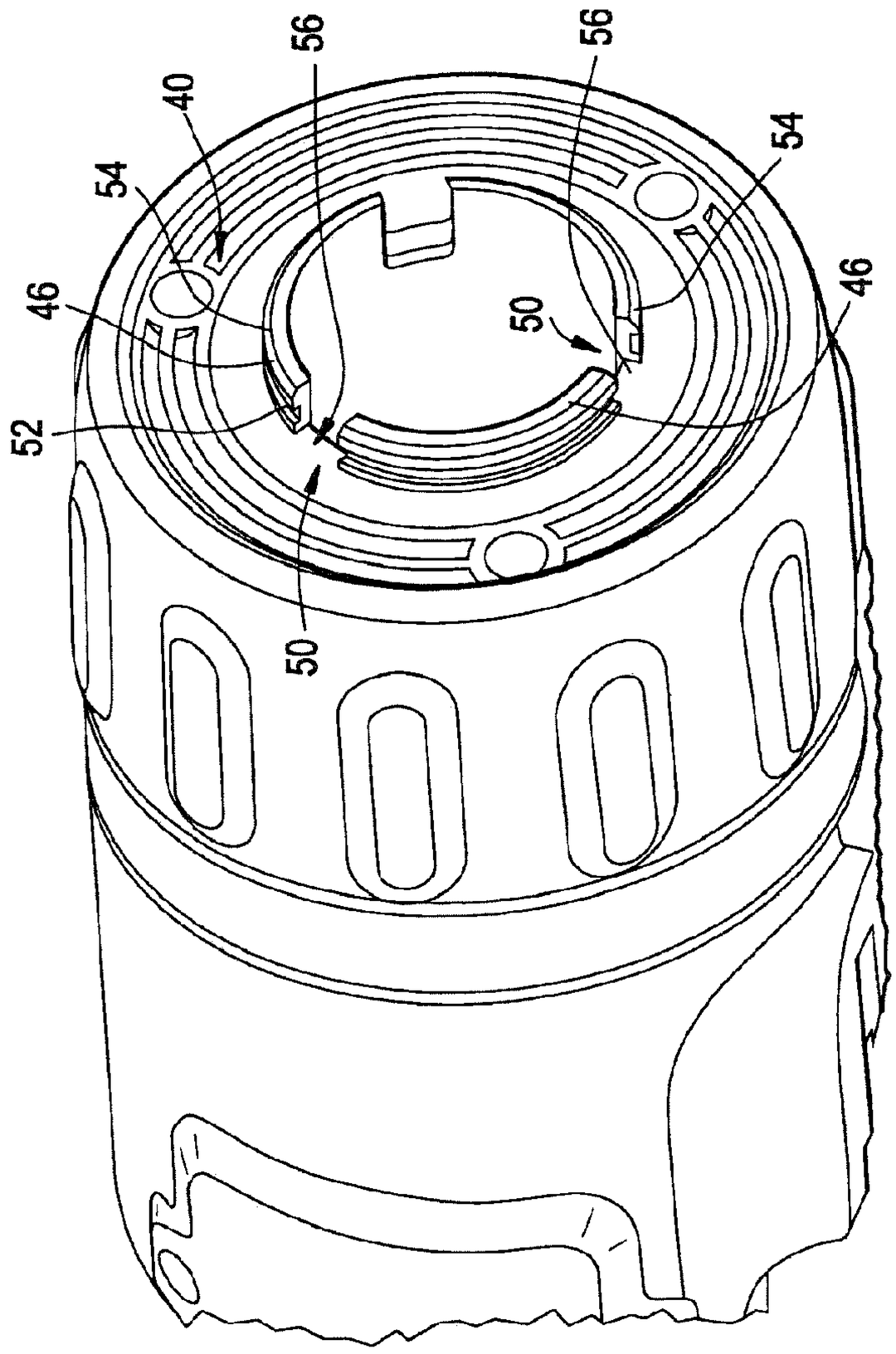

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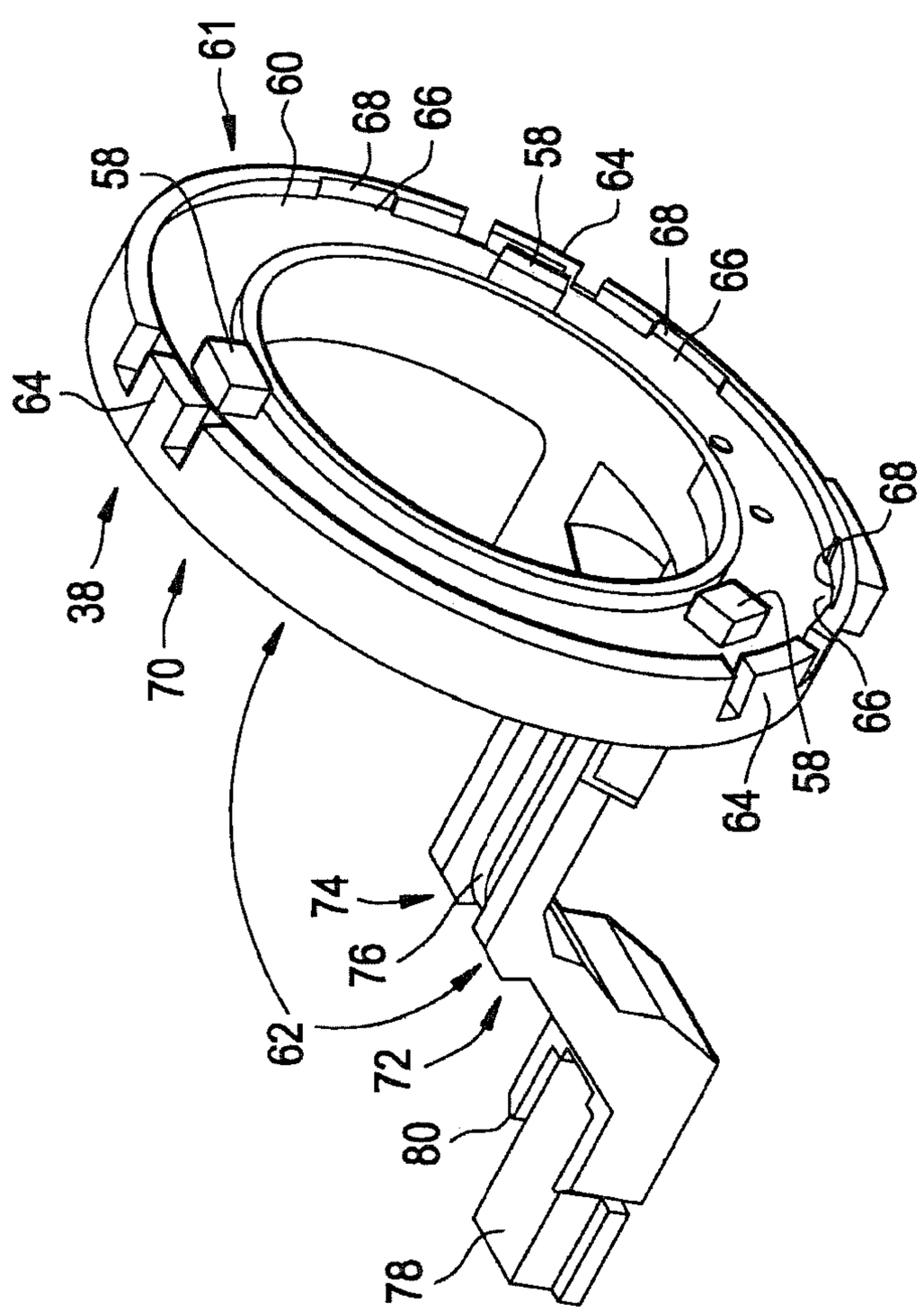

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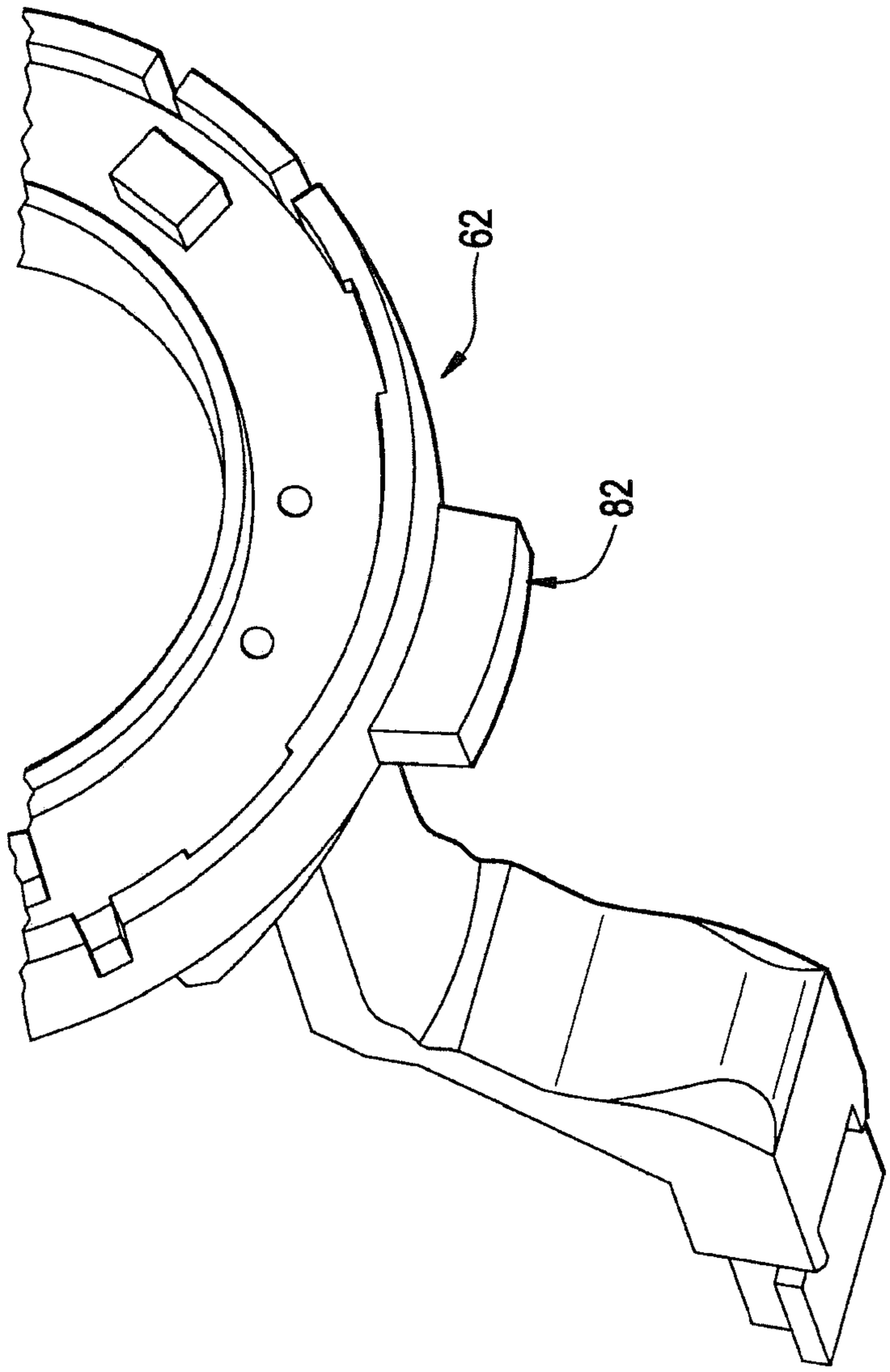

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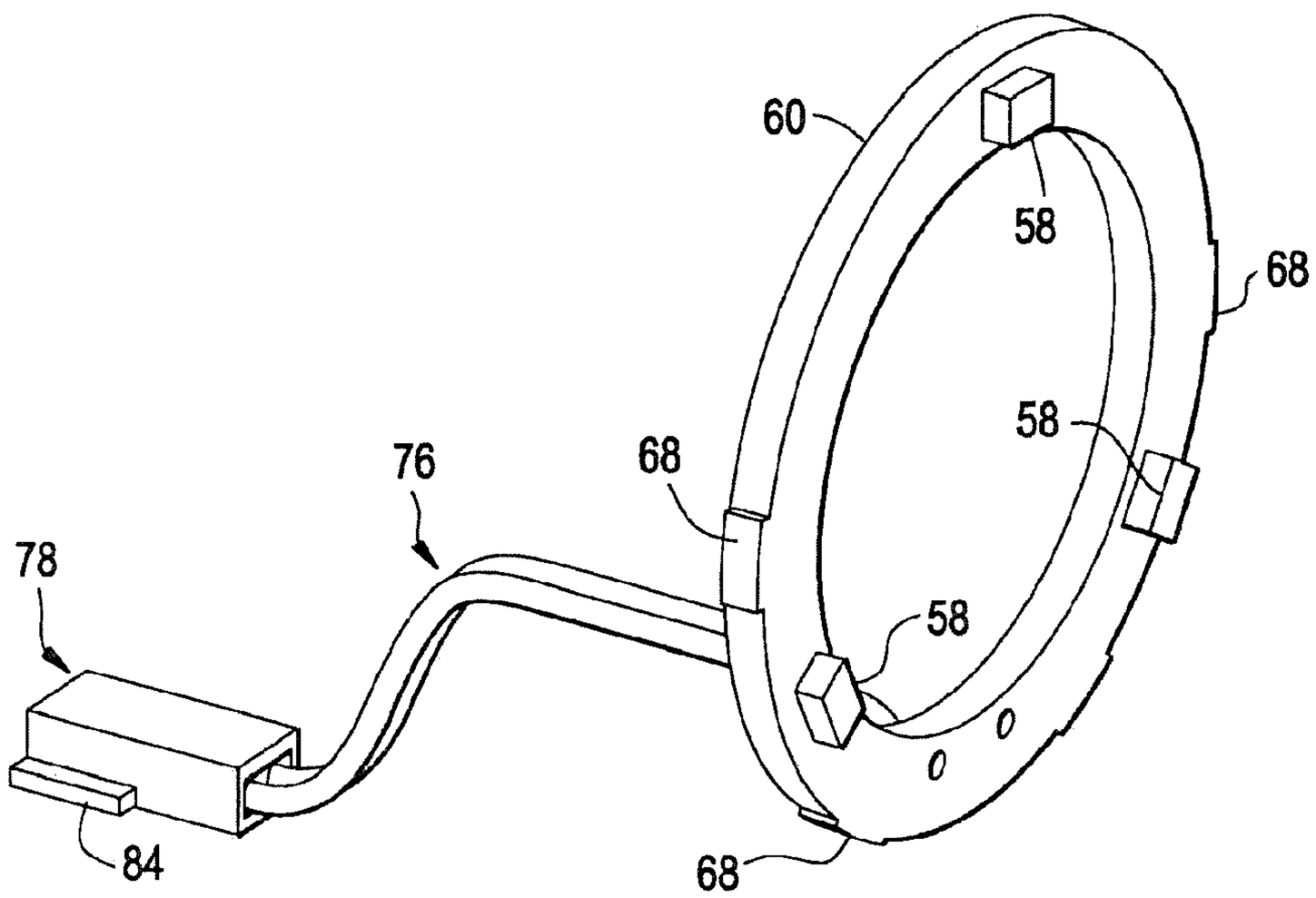

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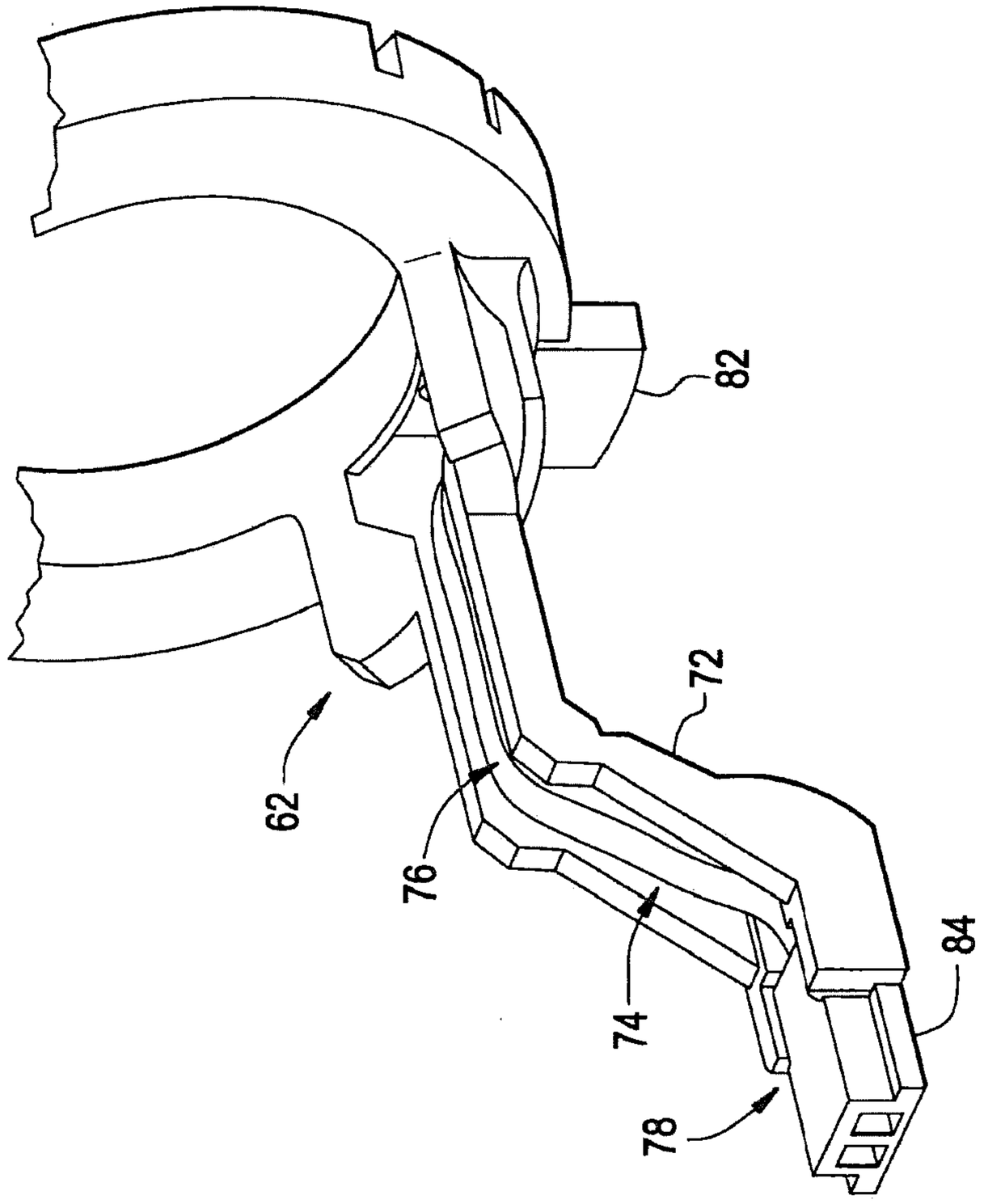

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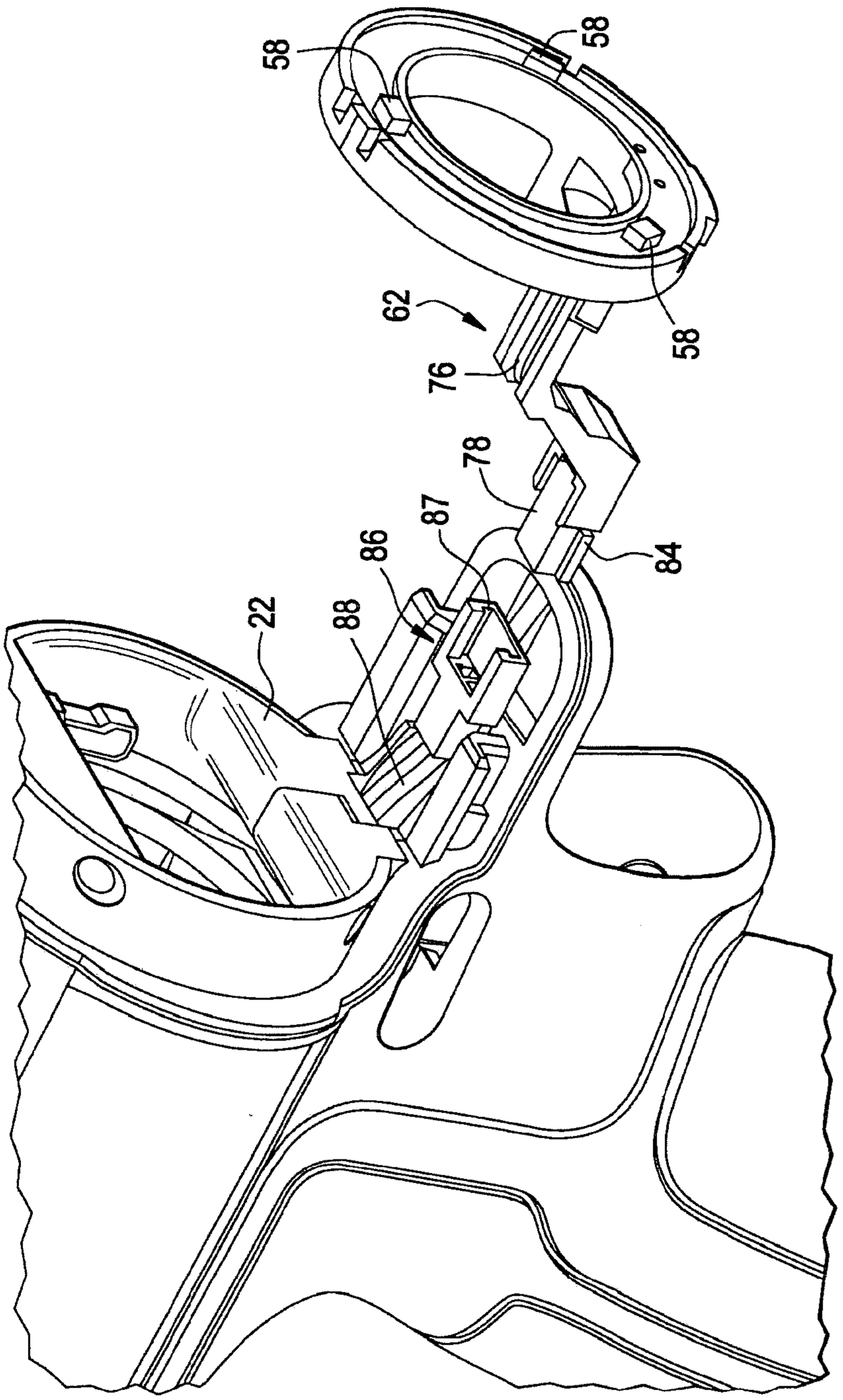

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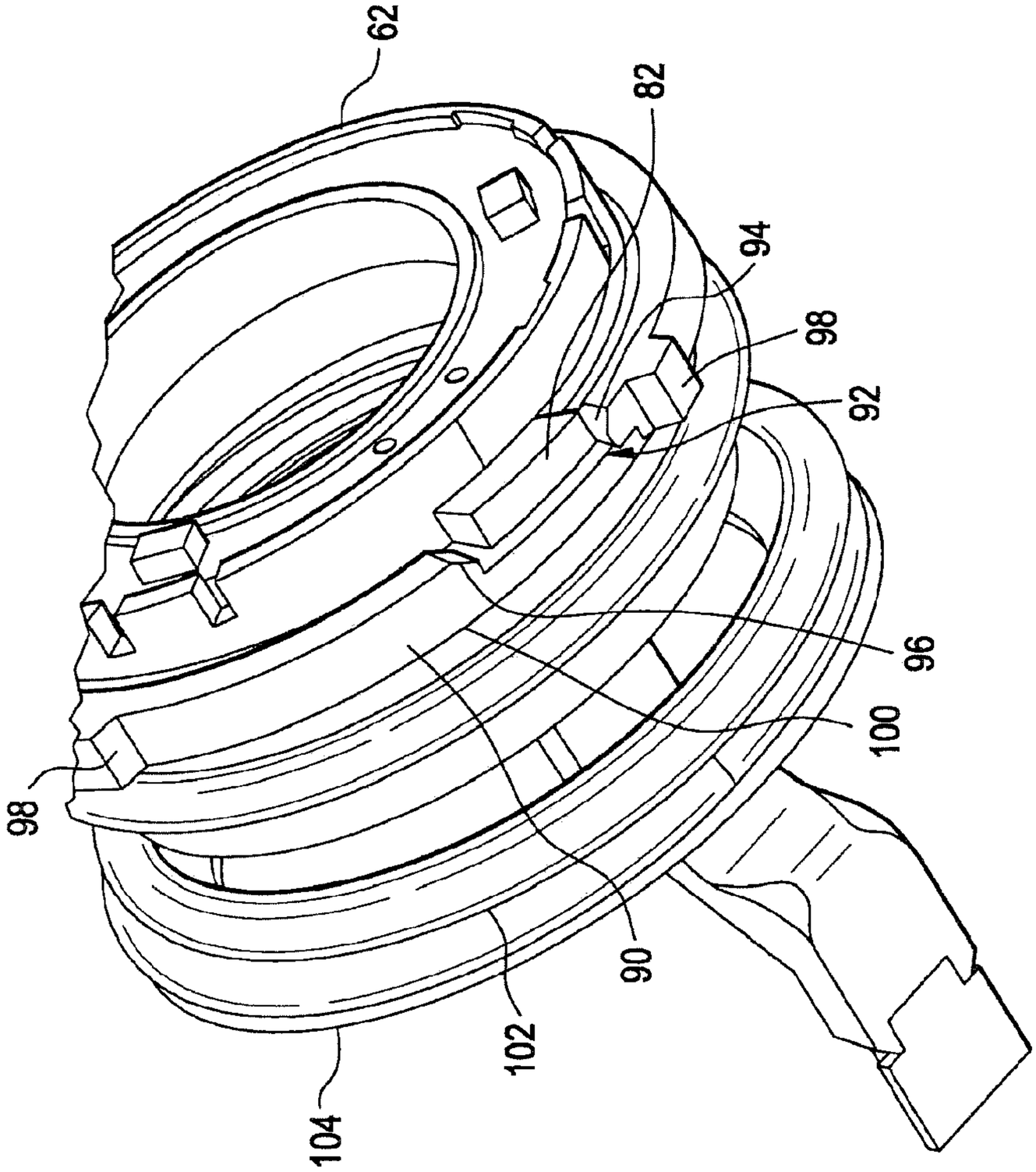

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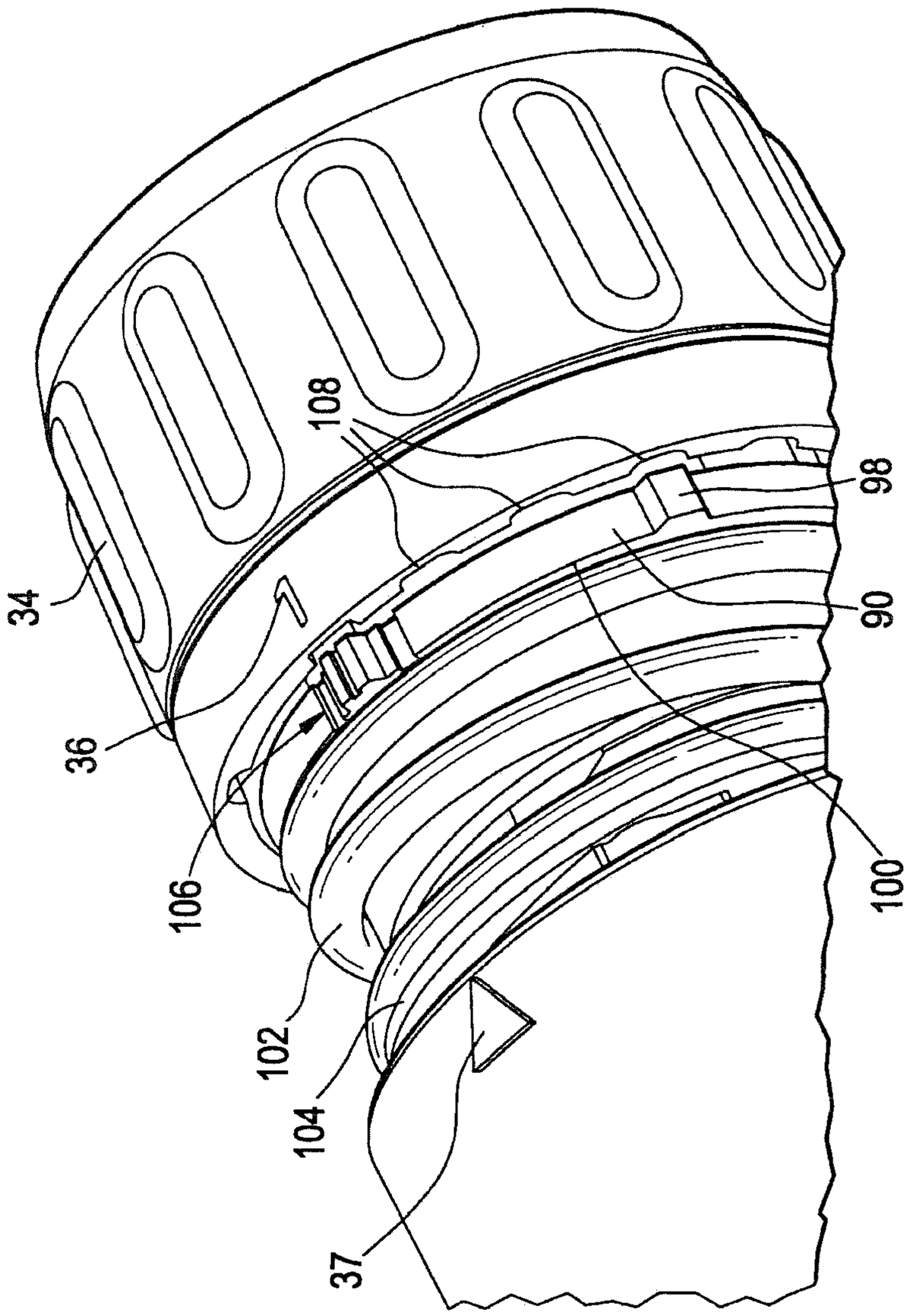

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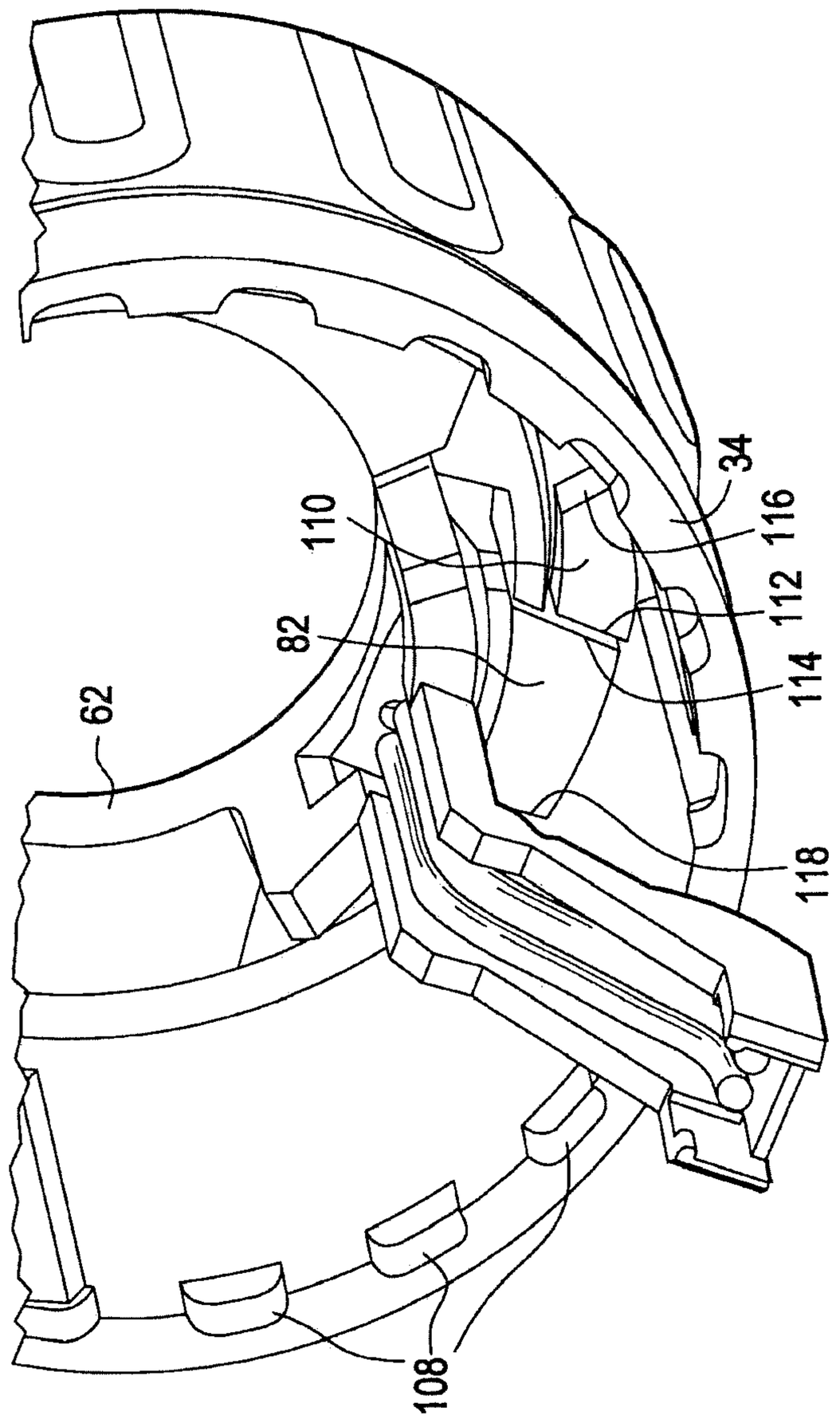

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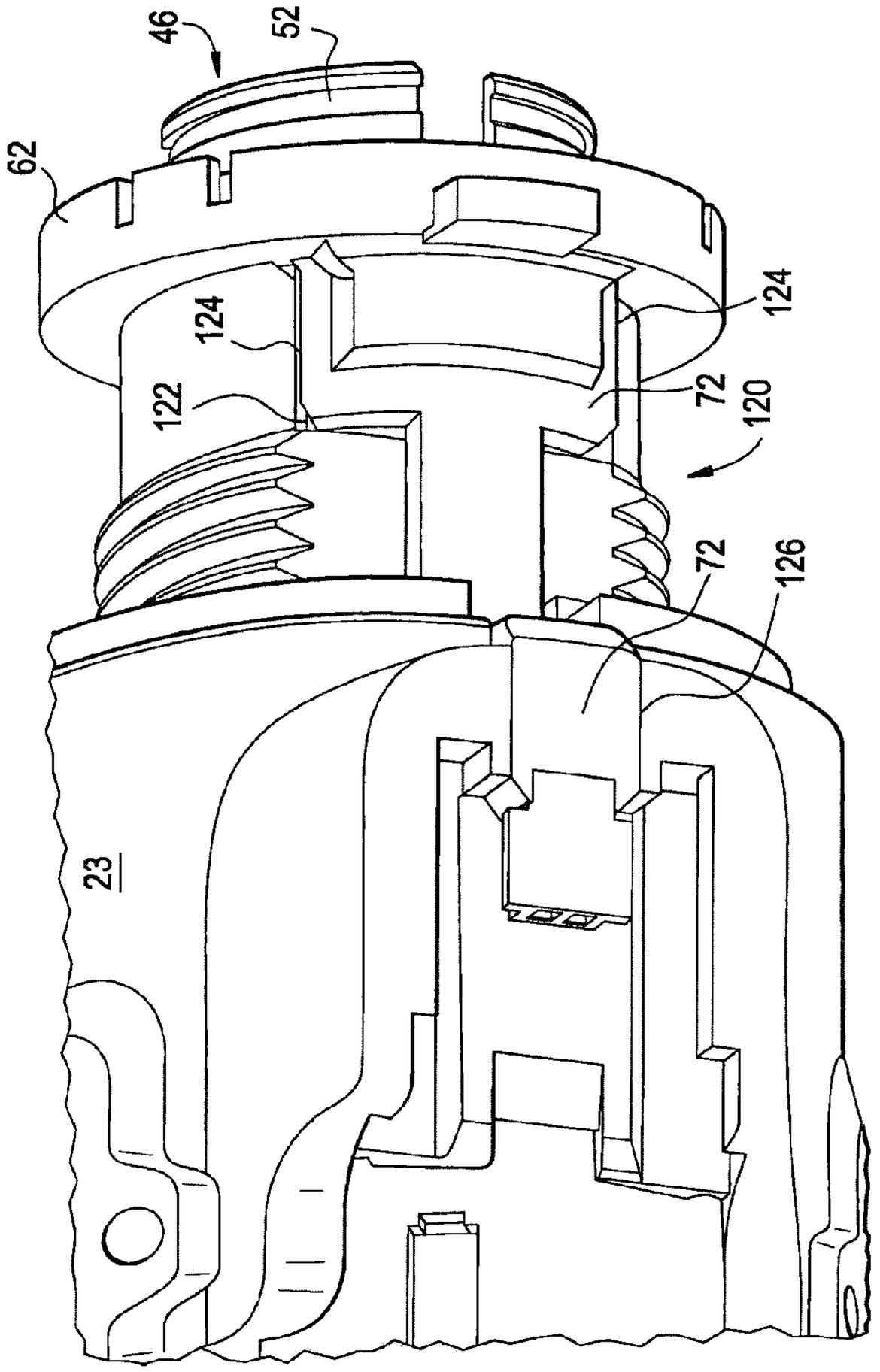

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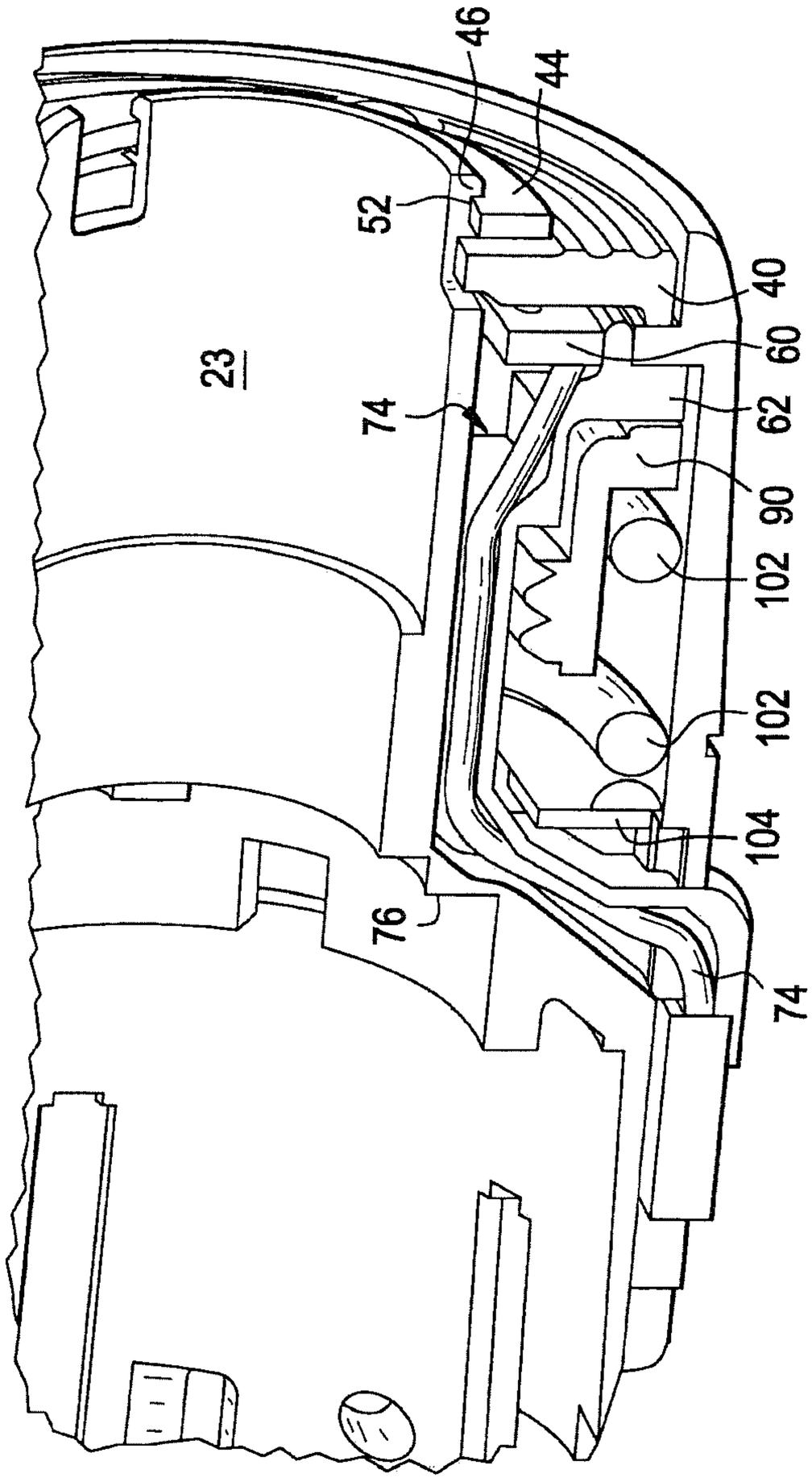

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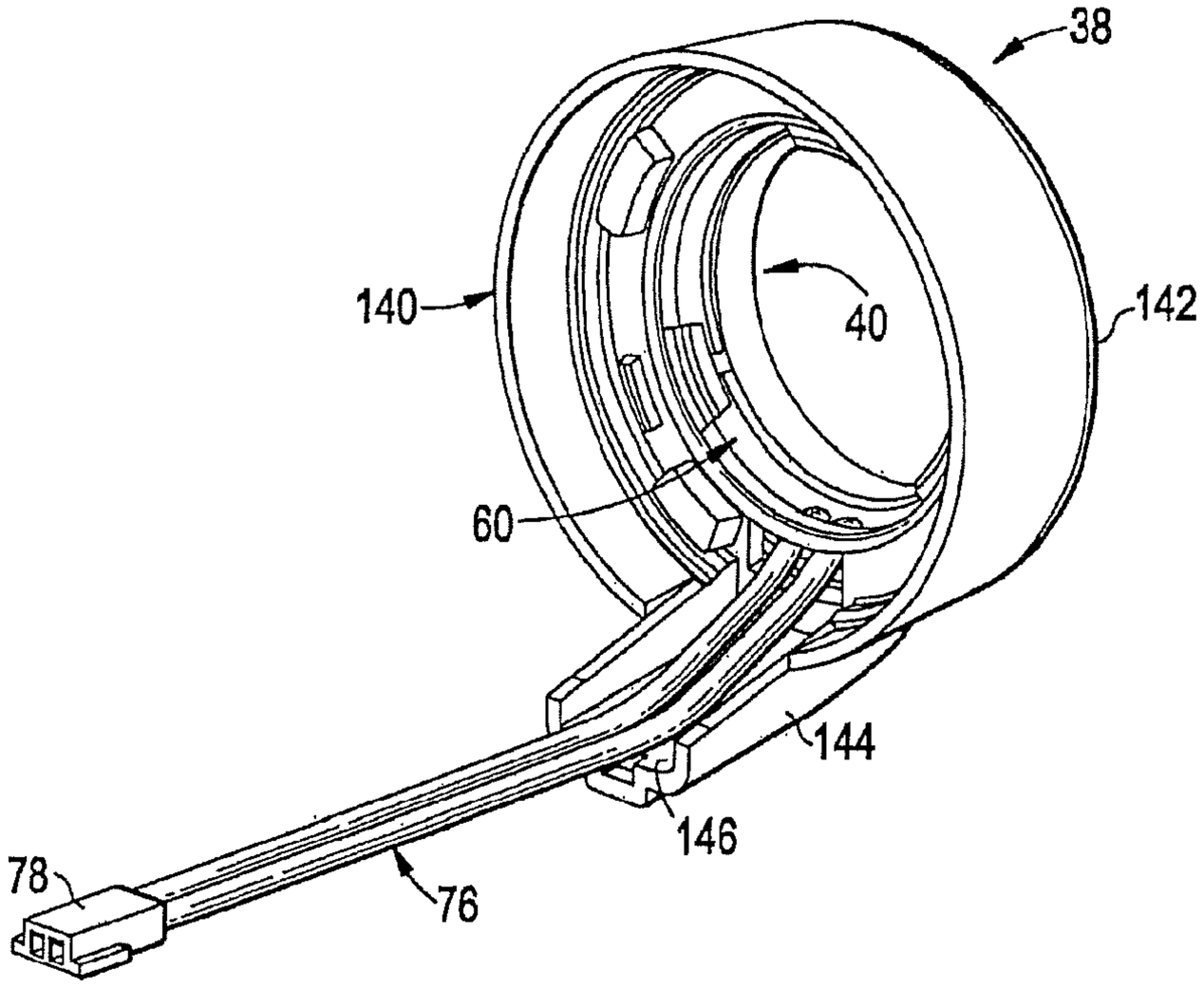

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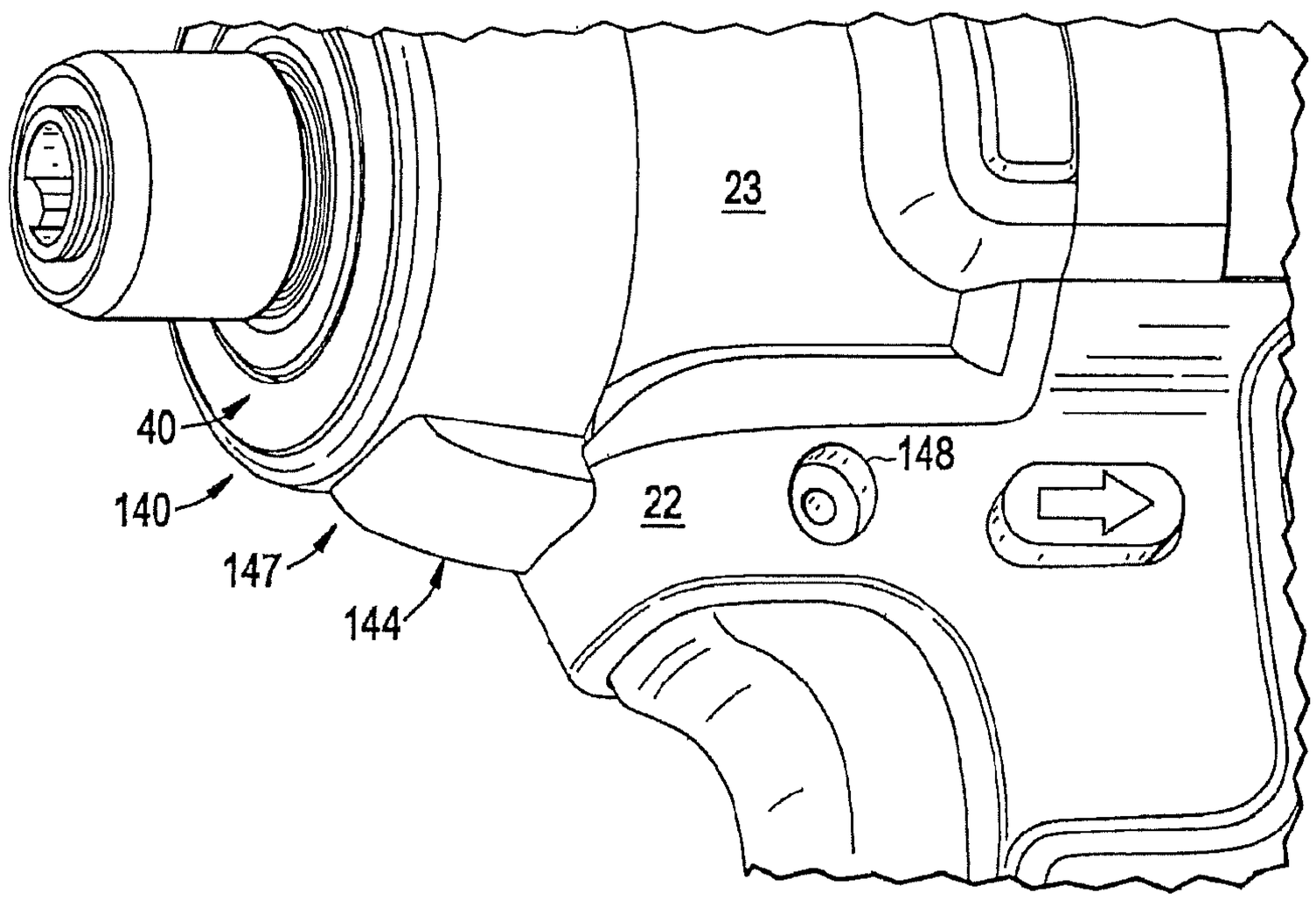

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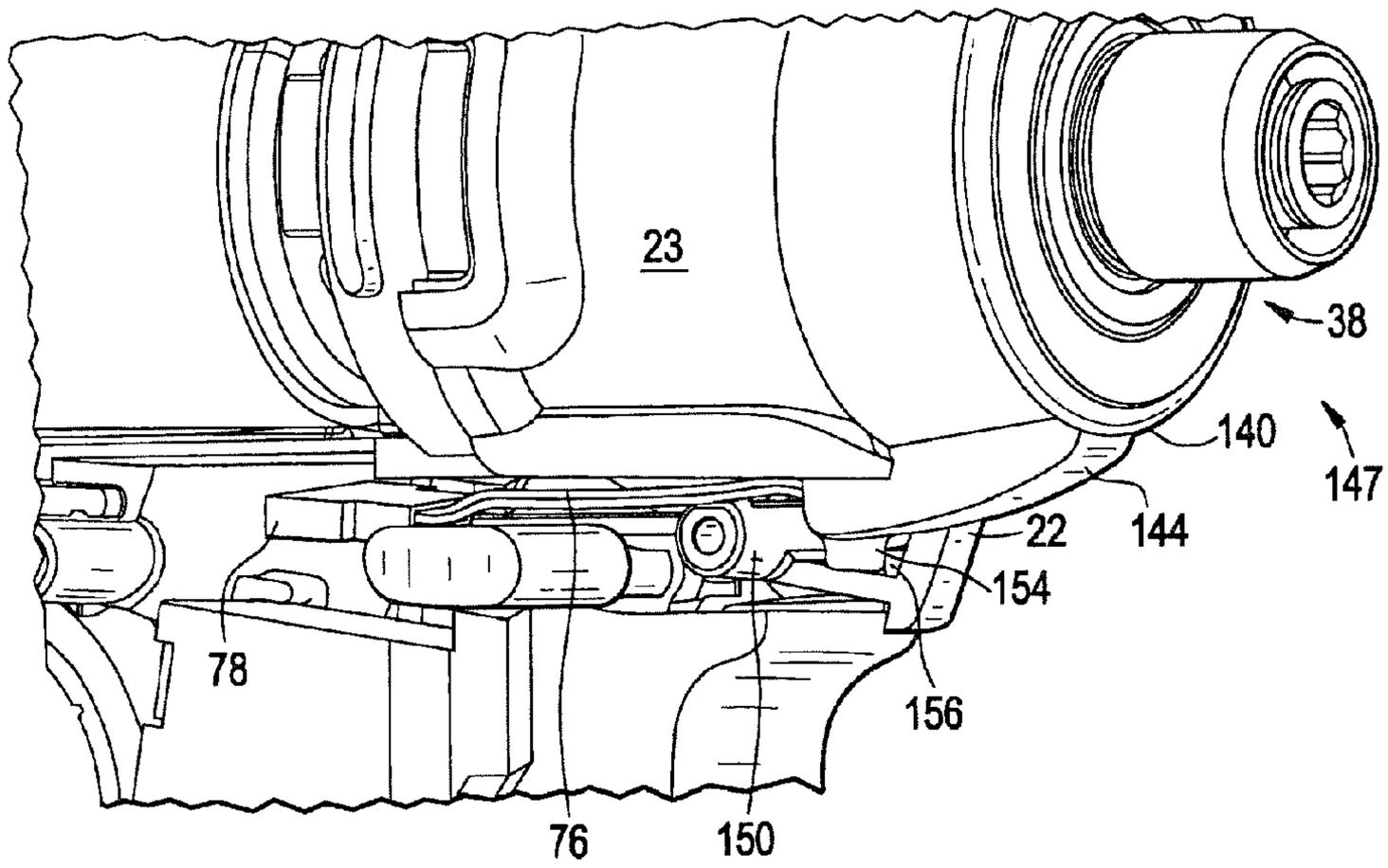
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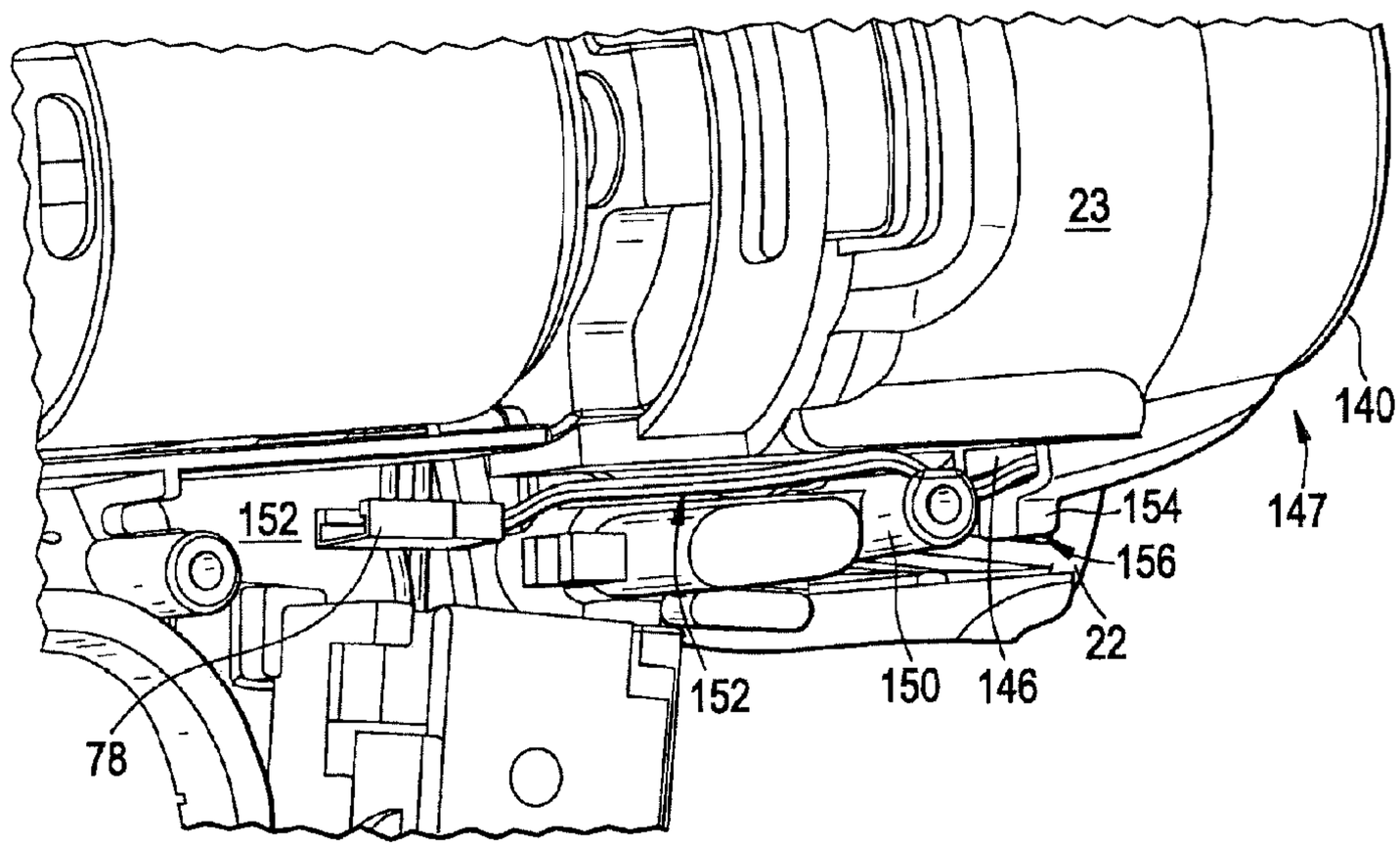
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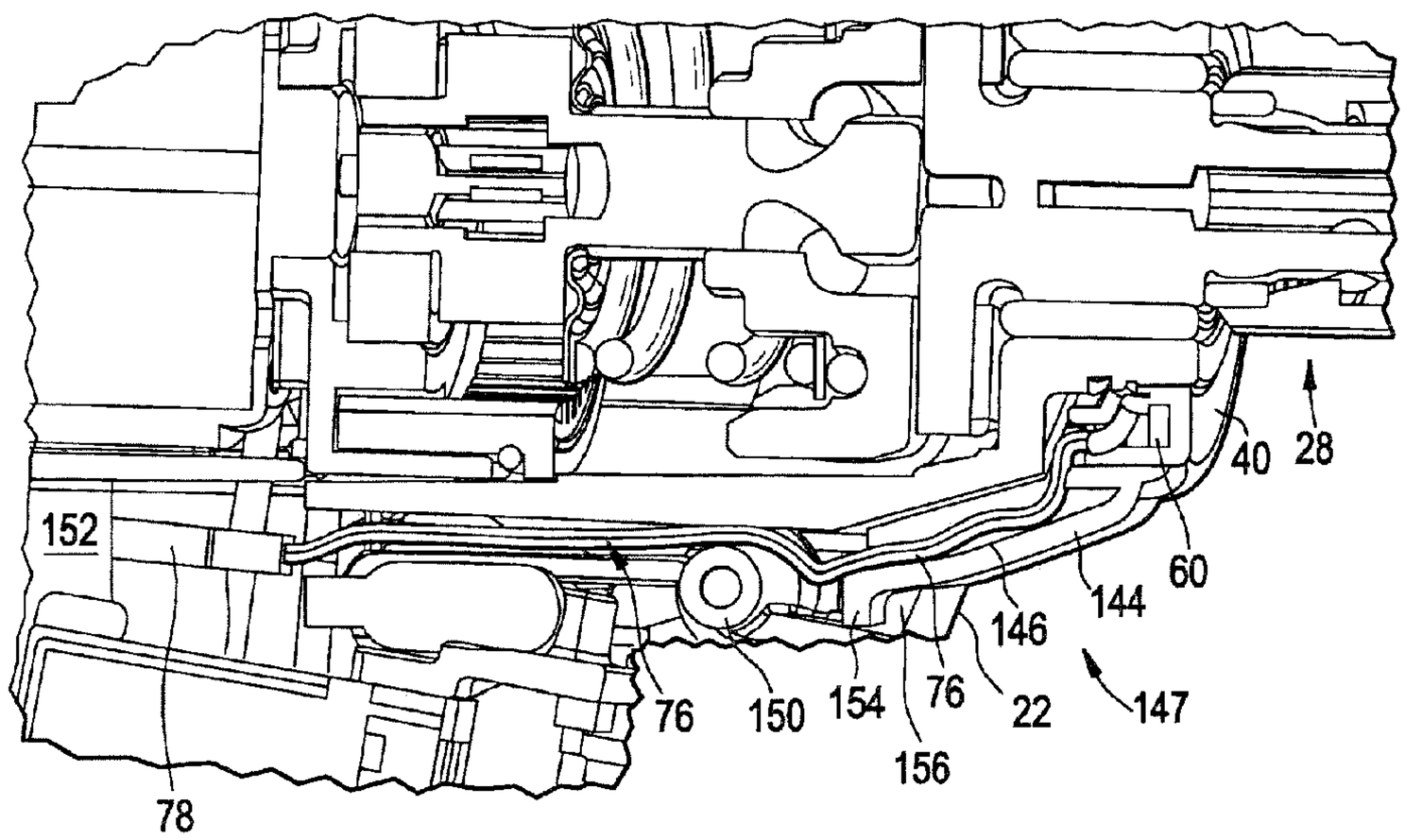

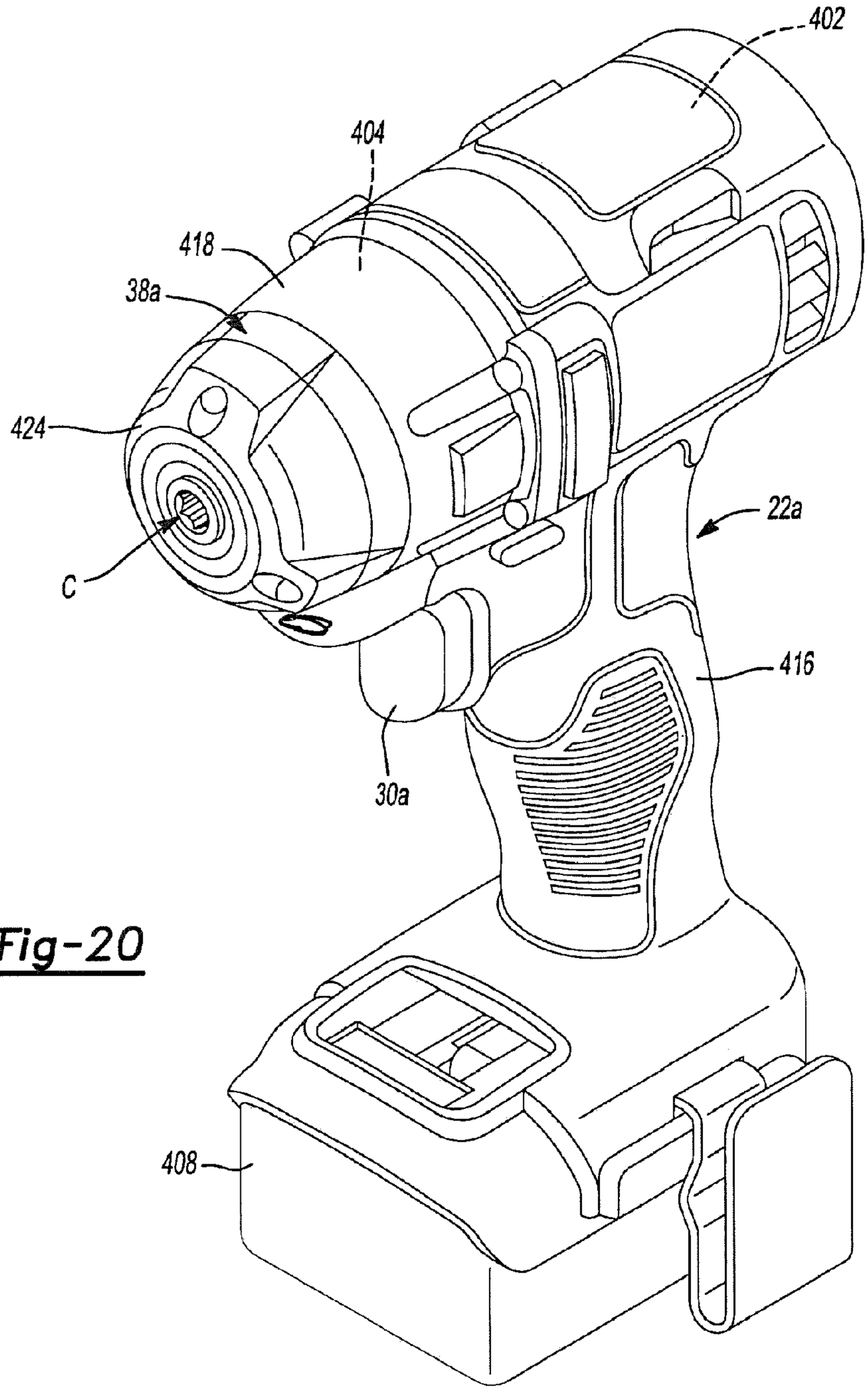

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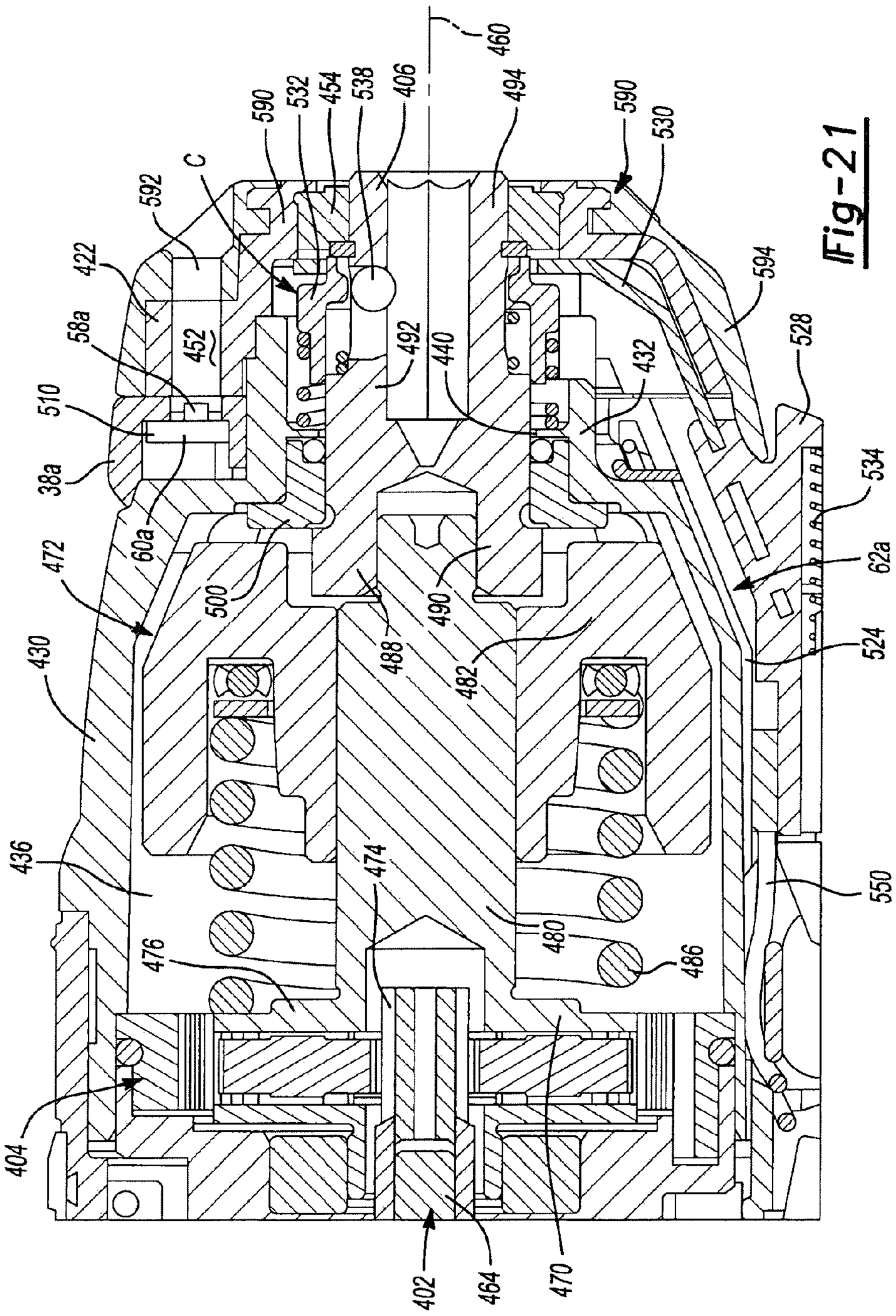
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Fig-21

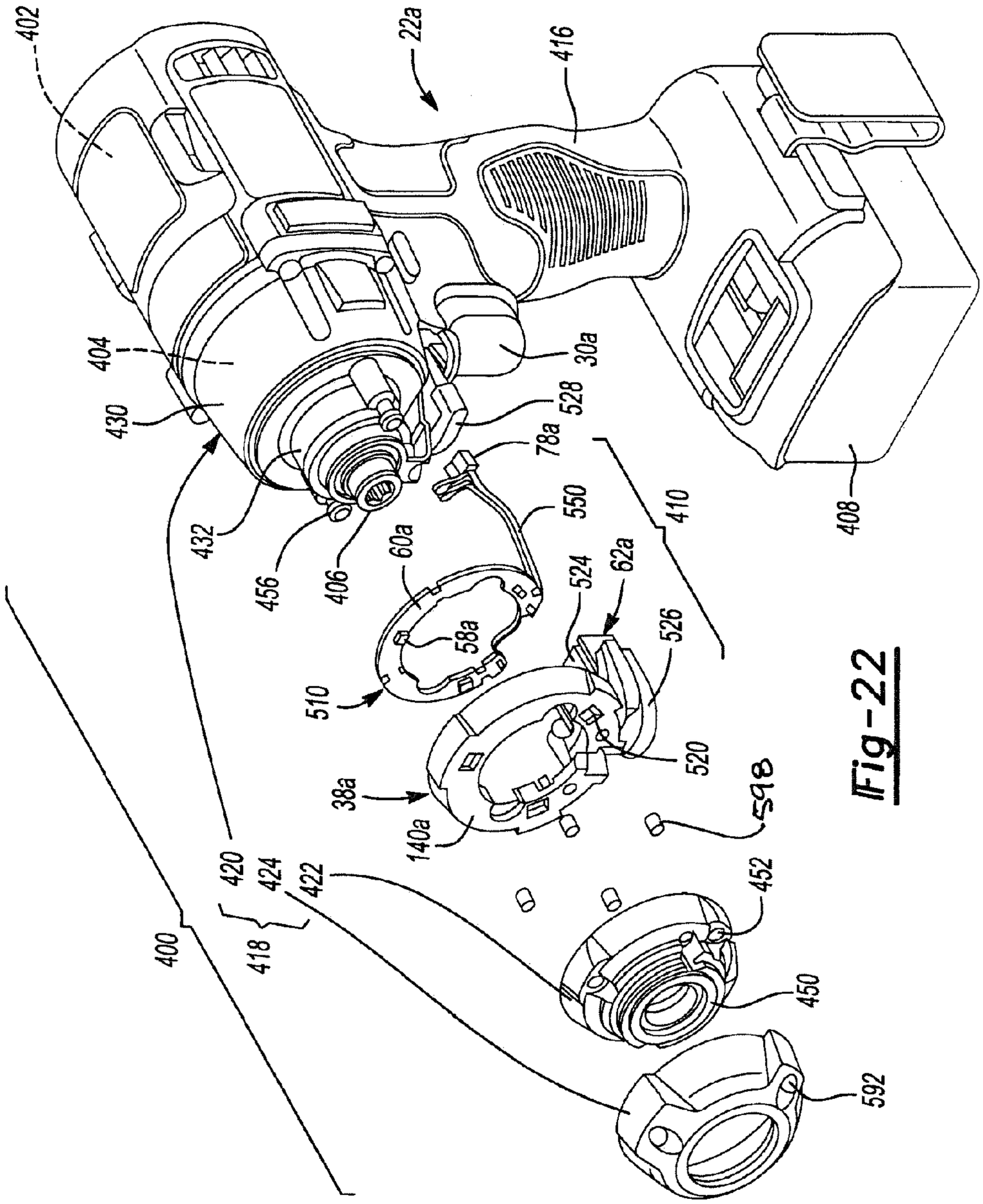
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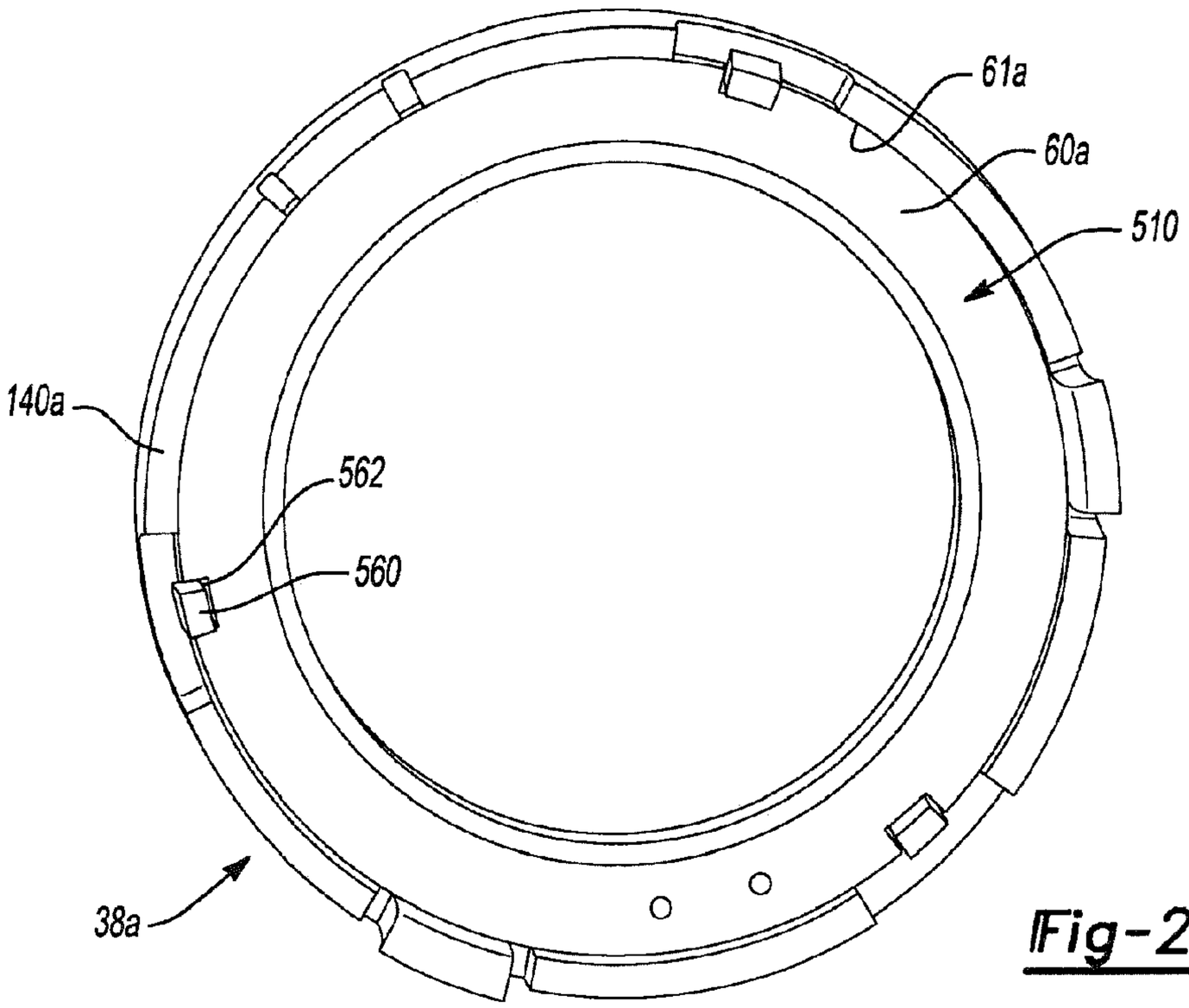
Fig-22



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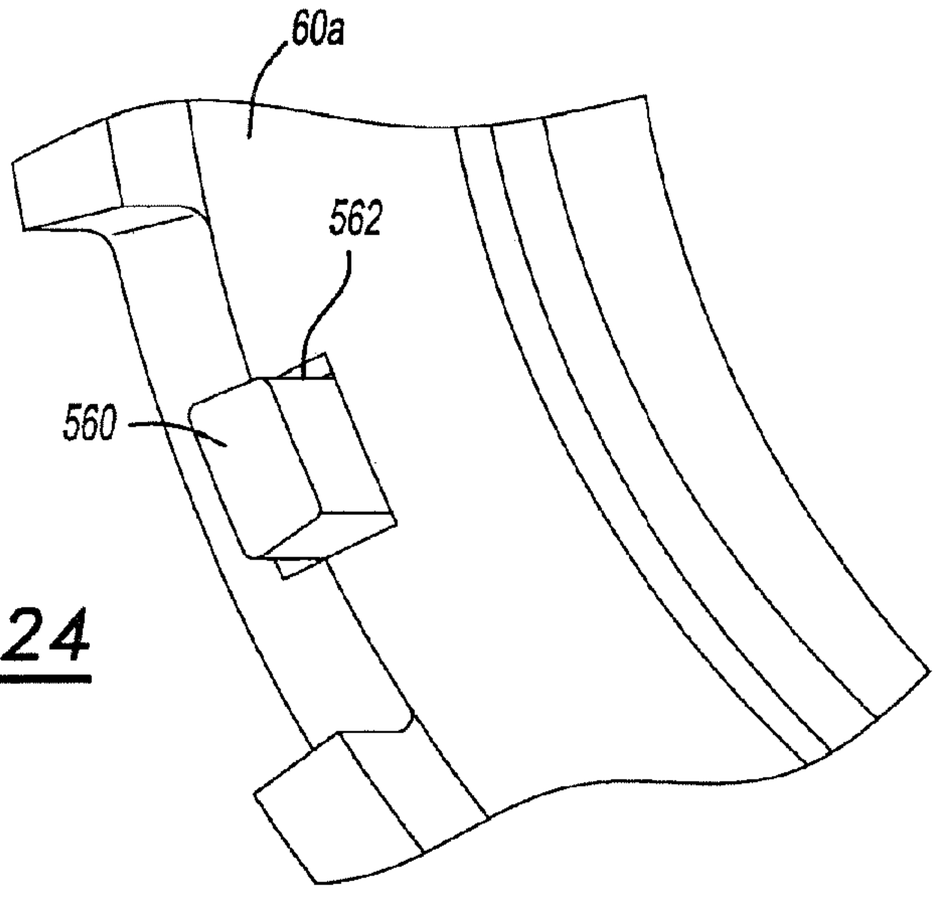
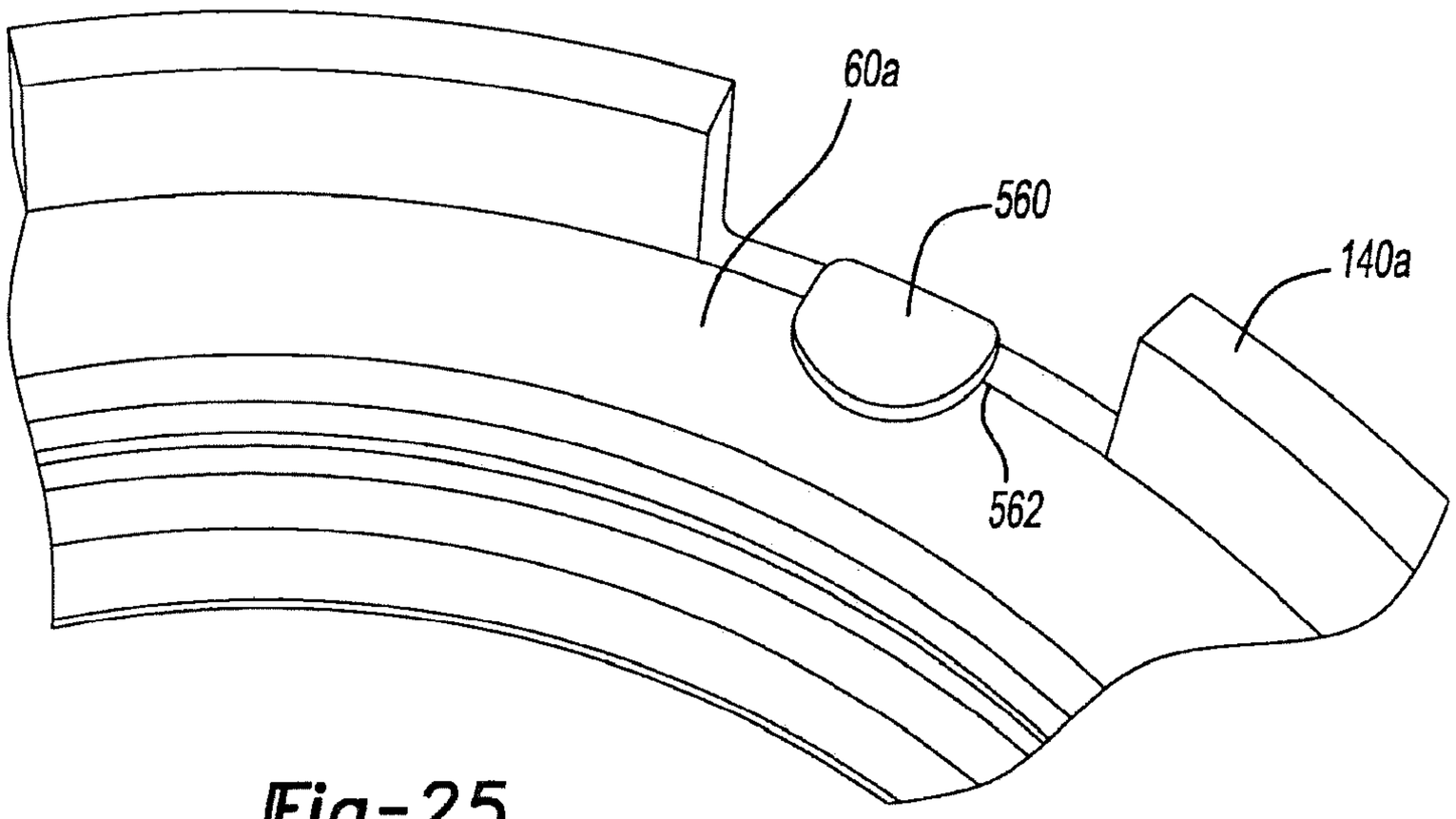


Fig-24



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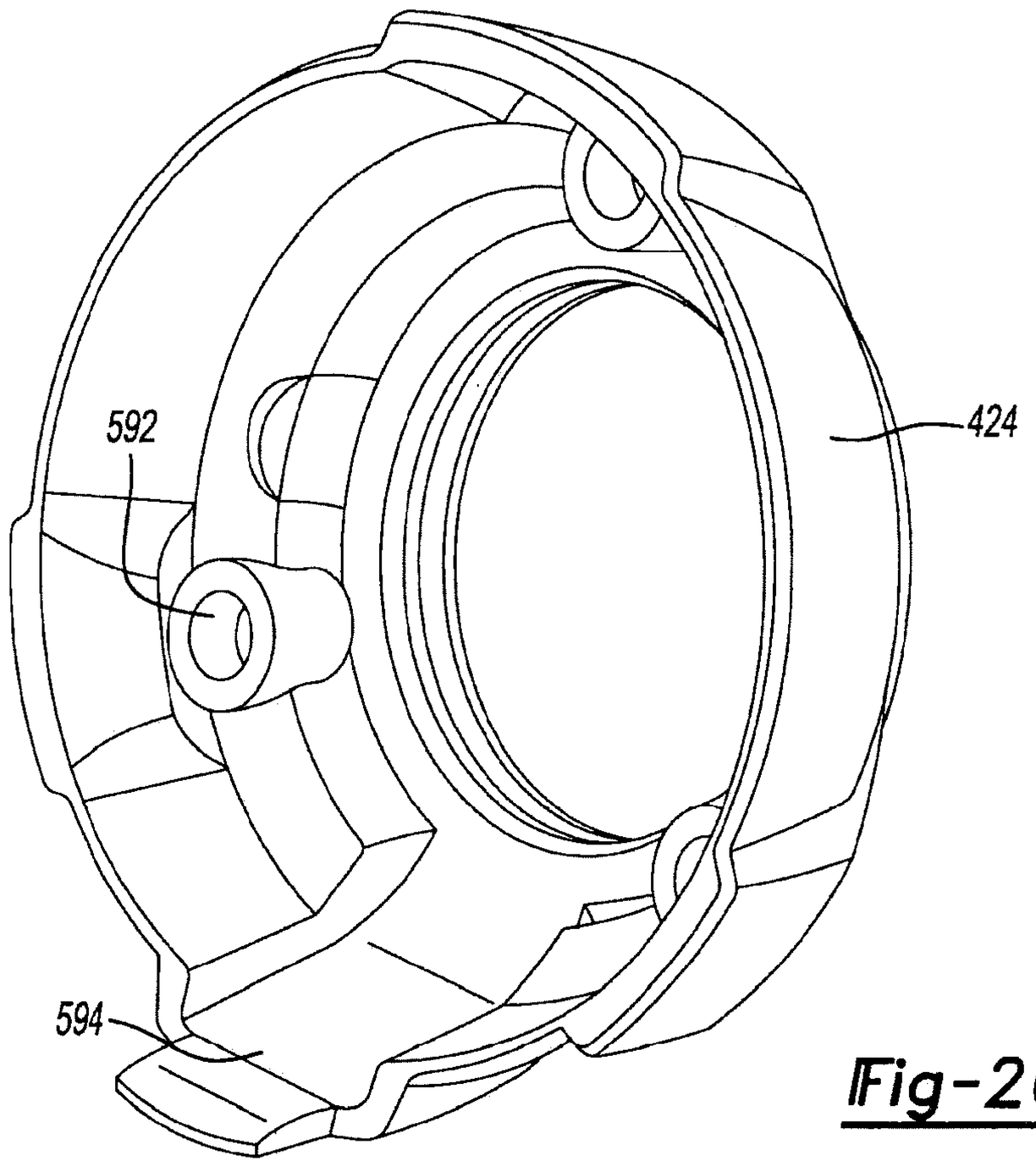

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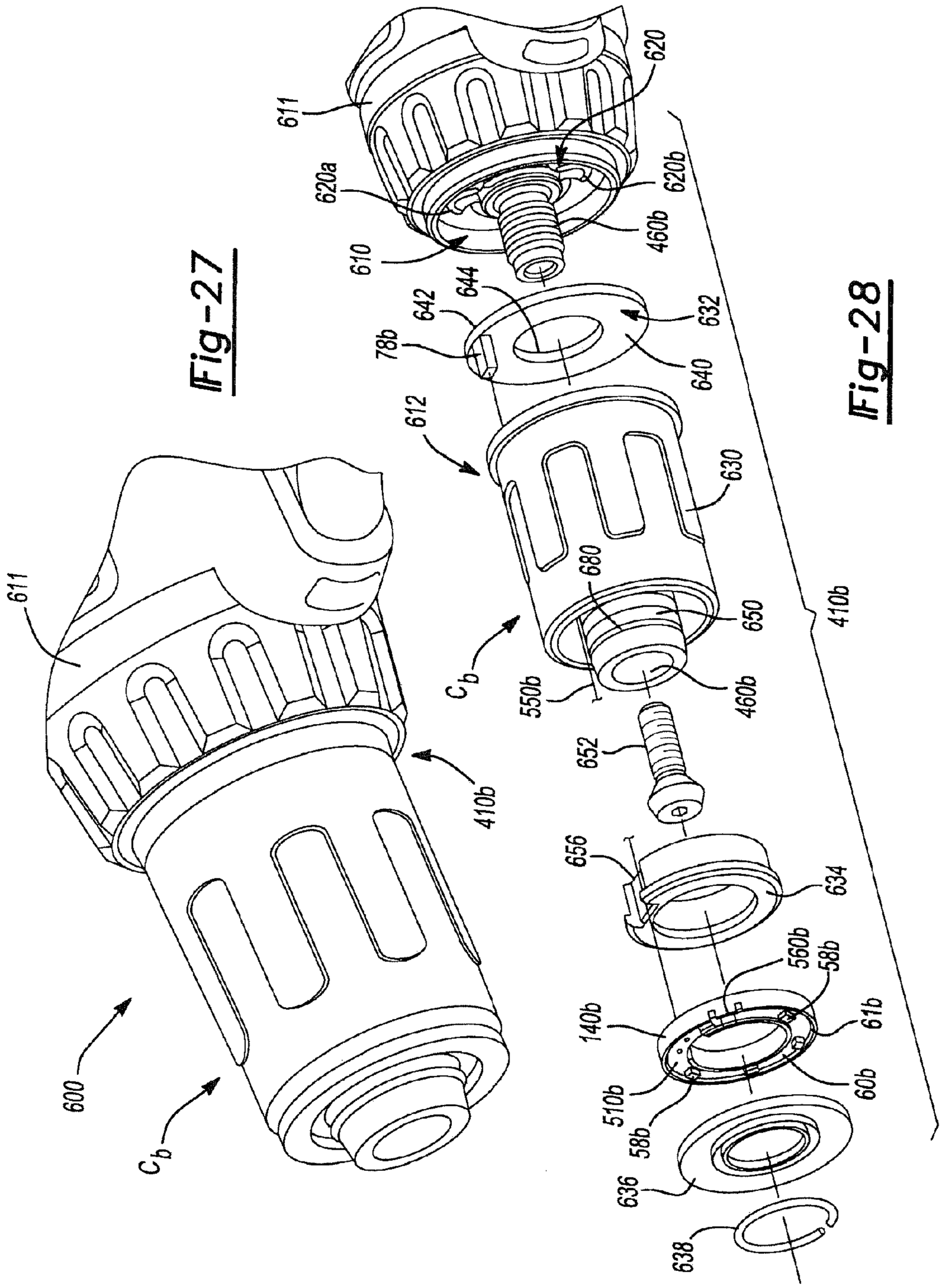
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Fig-27

Fig-28

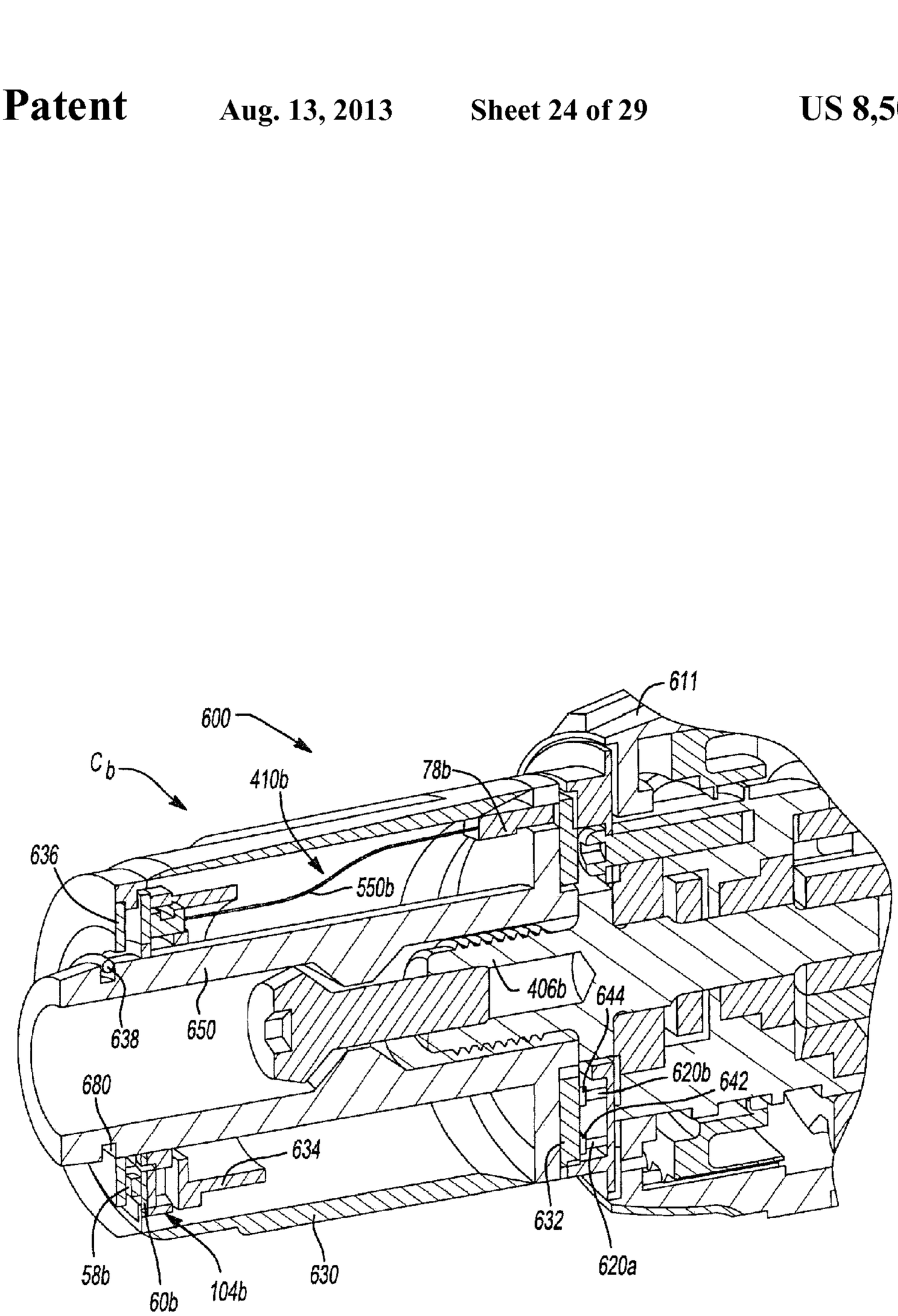
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Fig-29

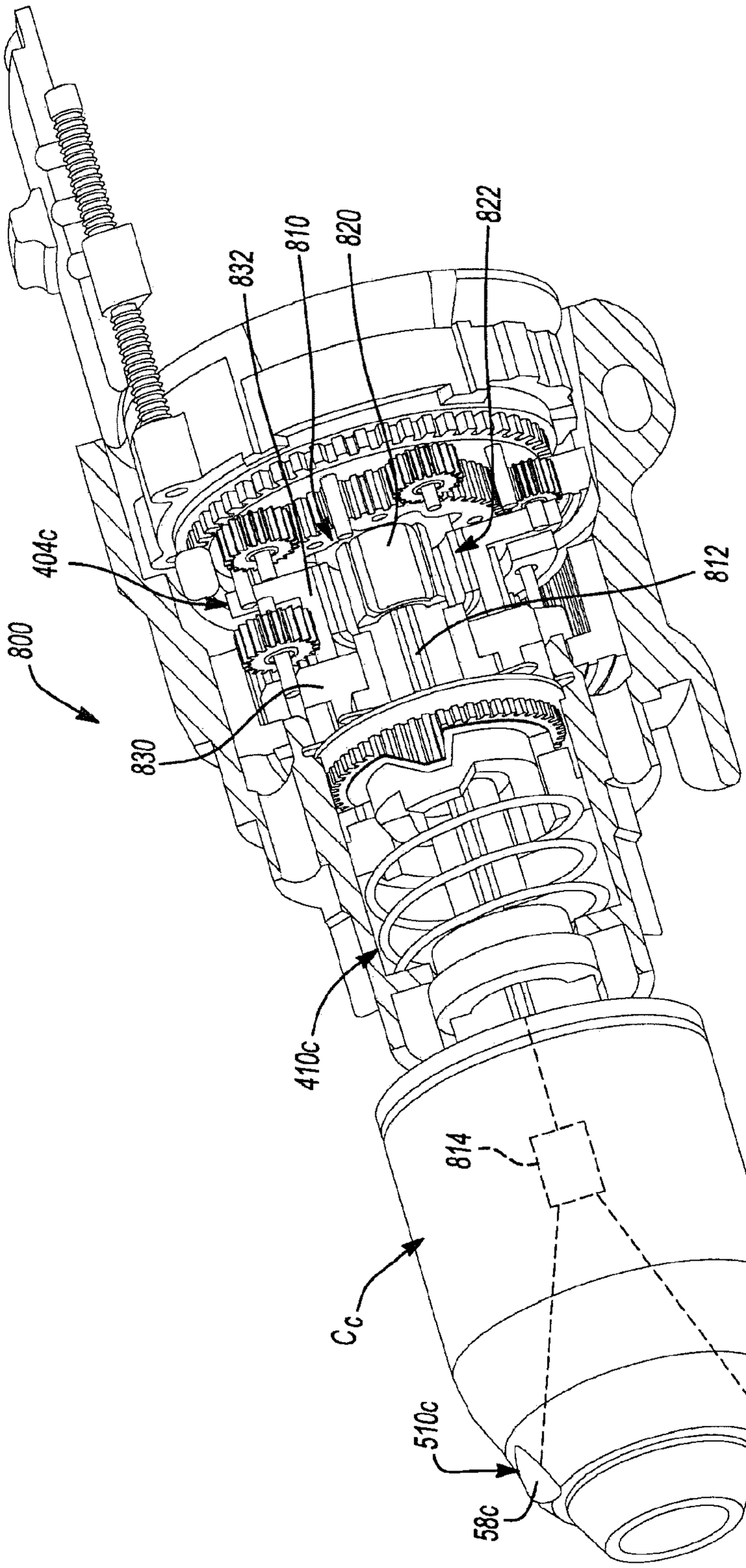

Fig-30

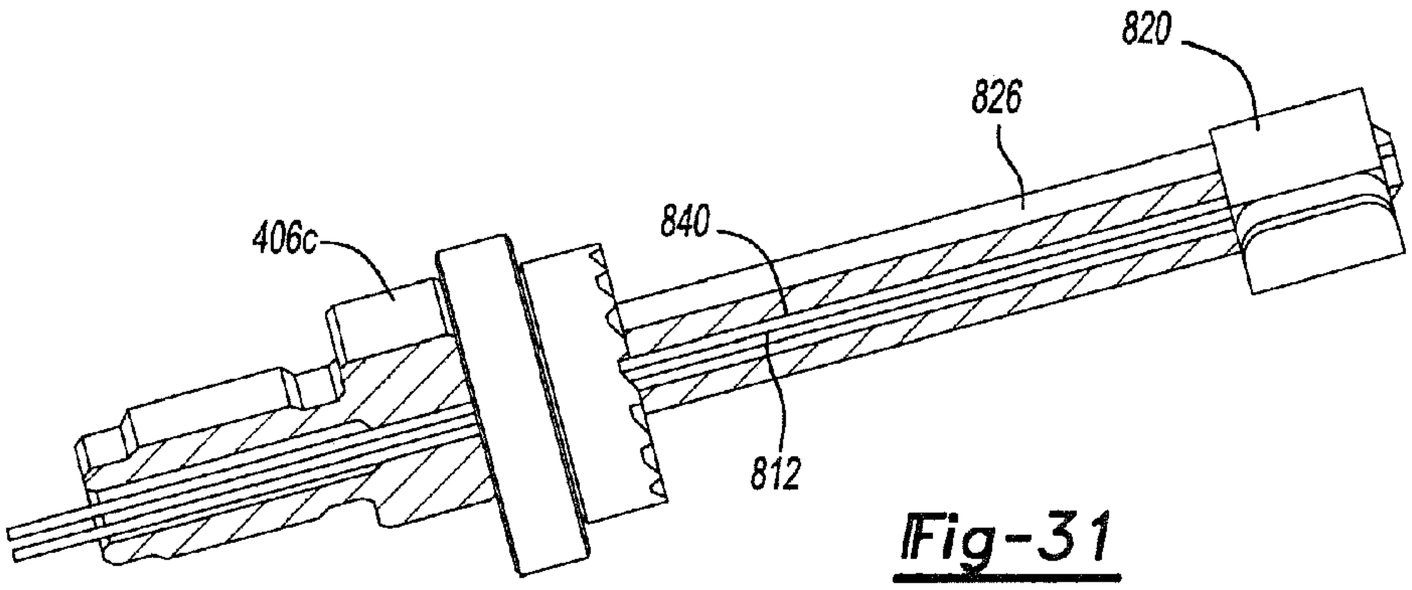

Fig-31

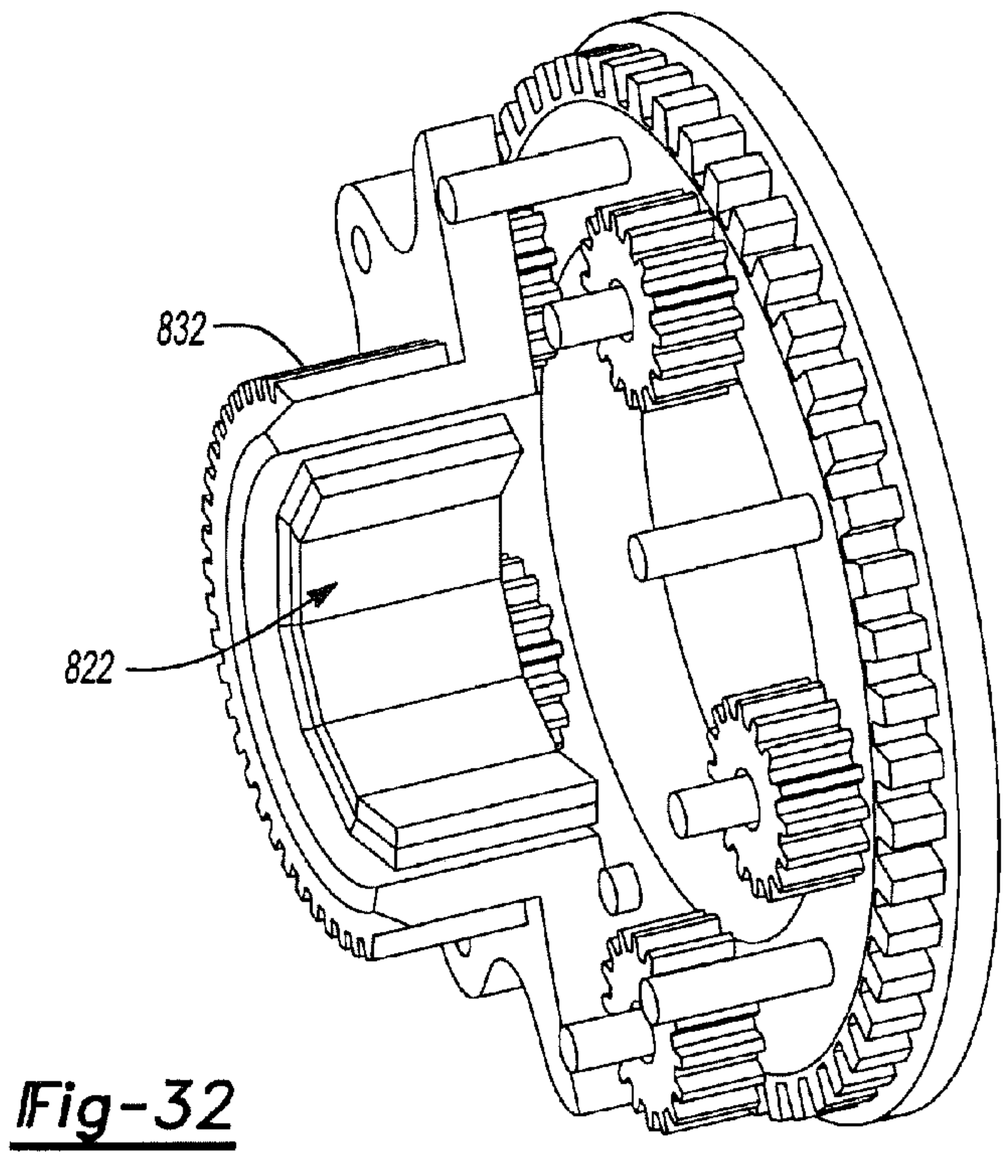

Fig-32

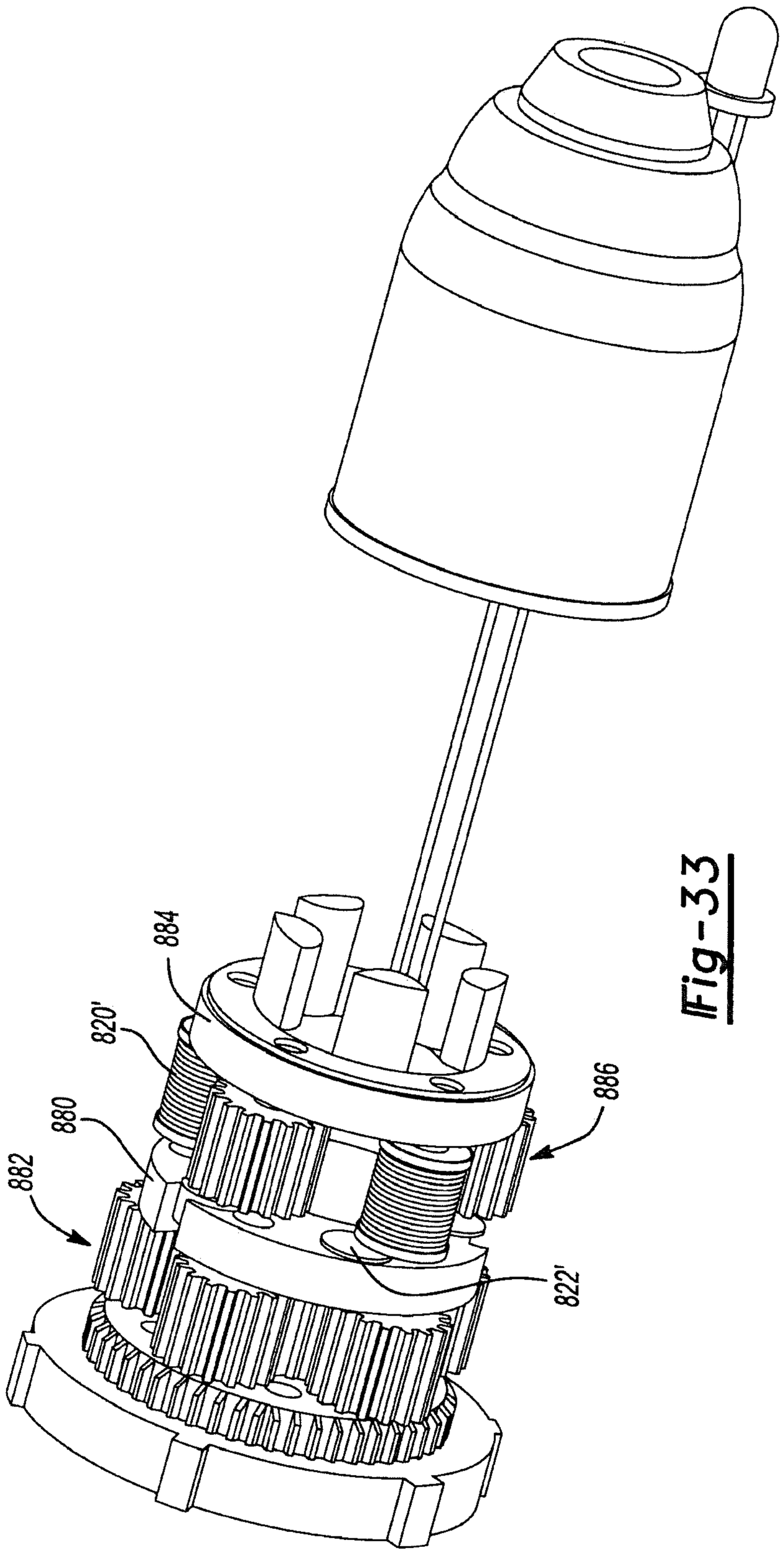

Fig-33

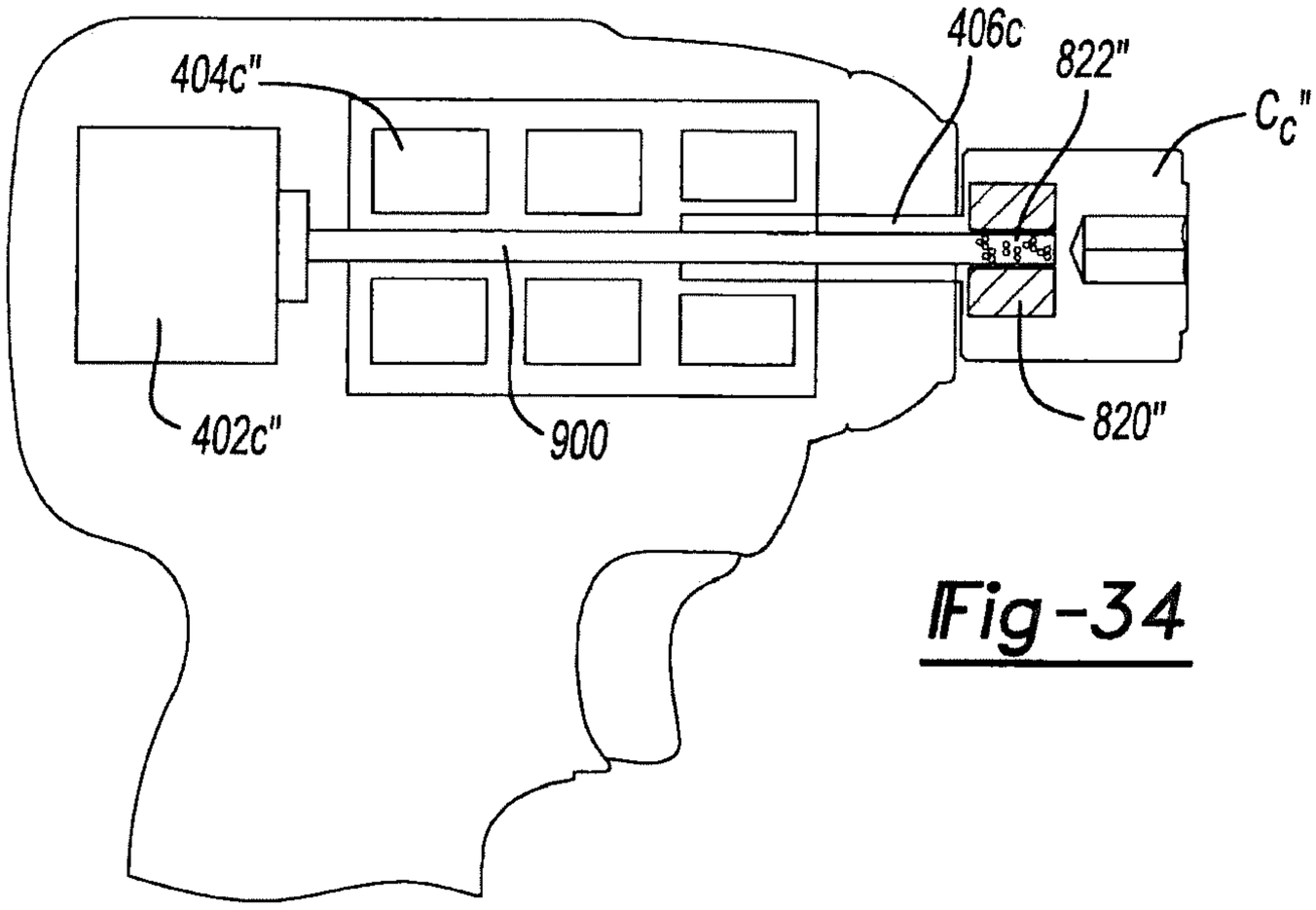

Fig-34

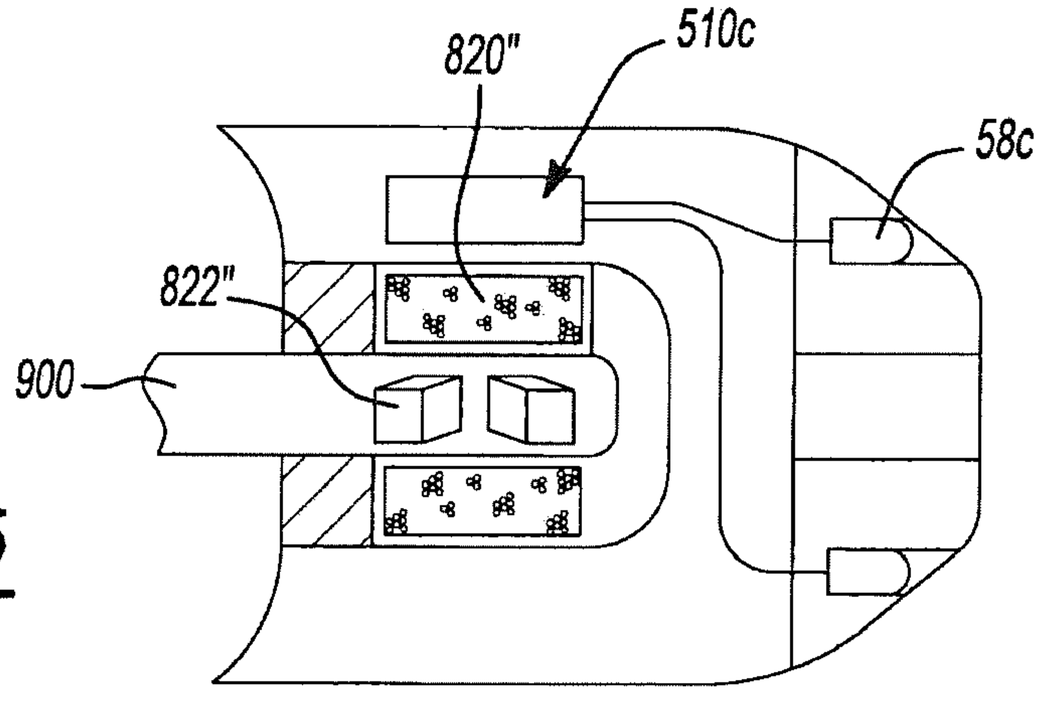

Fig-35

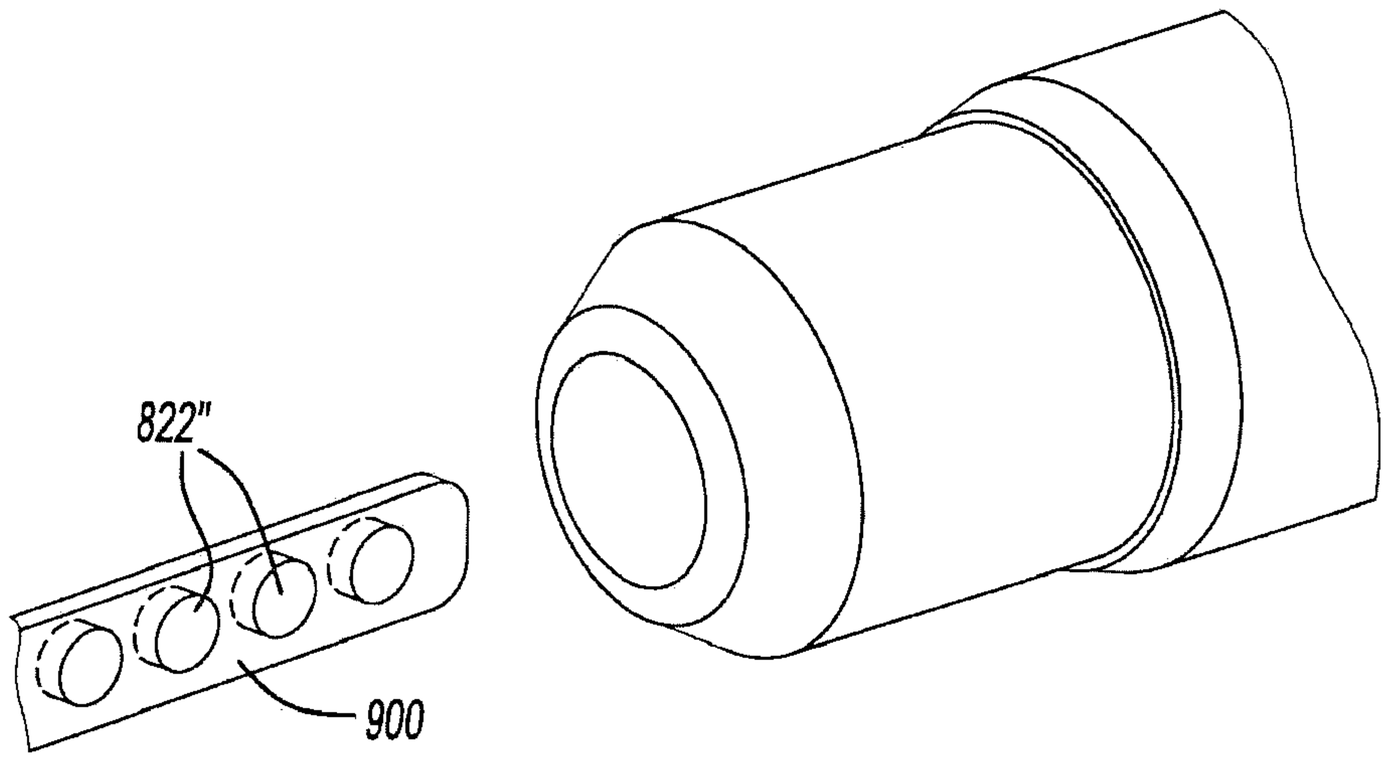

Fig-36

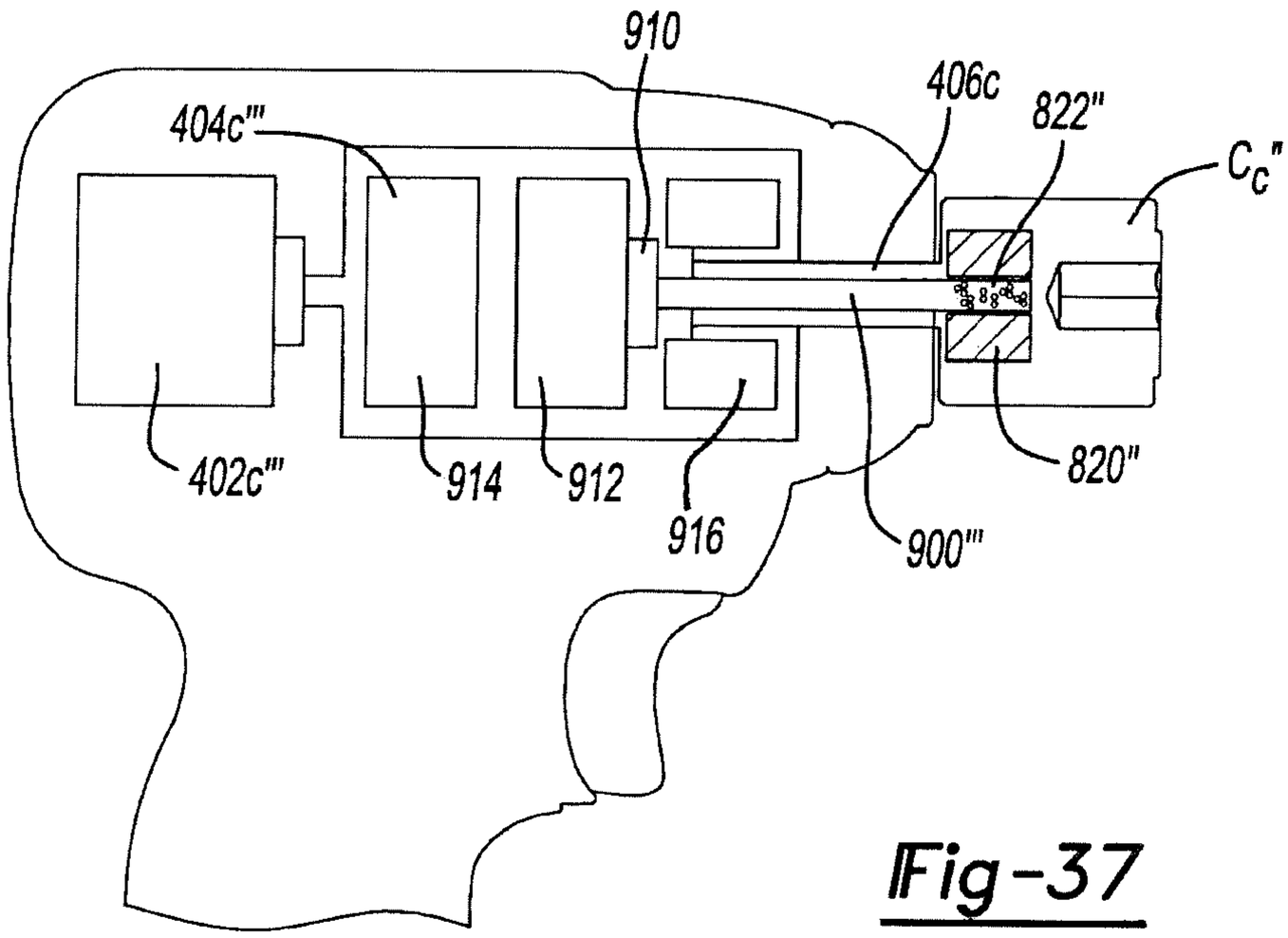

Fig-37

POWER TOOL WITH LIGHT FOR ILLUMINATING A WORKPIECE

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation of U.S. Ser. No. 12/895,051, filed Sep. 30, 2012, which is a continuation-in-part of U.S. Ser. No. 12/379,585 filed Feb. 25, 2009, and a continuation-in-part of U.S. Ser. No. 12/859,036 filed Aug. 18, 2010. The disclosures of each the aforementioned applications are incorporated by reference as if fully set forth in detail herein.

FIELD

The present disclosure relates to a power tool with a light for illuminating a workpiece.

BACKGROUND

This section provides background information related to the present disclosure which is not necessarily prior art.

Power tools are often used in a variety of conditions ranging from well-lit indoor work spaces to outside construction sites or other areas that are not always well-lit. Accordingly, it is desirable to provide a method or apparatus that permits a power tool to have a lighting feature that will illuminate the workpiece that is being machined or worked on by the power tool. Such a lighting feature will assist a user to be able to adequately see the workpiece or work area that is being worked on or machined by the power tool even in substandard light conditions.

Because power tools may be used in adverse environmental conditions, it is desirable to protect such a lighting feature from the adverse environmental conditions.

SUMMARY

This section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope or all of its features.

In one form, the present disclosure provides a power tool that includes a housing assembly, an output spindle, first and second bearings, a motor, a transmission and a light system. The housing assembly has a housing structure and a case that is coupled to the housing structure. The case includes a first case member and a second case member. The output spindle is at least partially received in the case. The first bearing is mounted to the first case member and is configured to support a first axial end of the output spindle. The second bearing is mounted to the second case member and is configured to support a second, opposite axial end of the output spindle. The motor is housed in the housing assembly and provides a source of rotary power. The transmission is housed in the housing assembly and drivingly couples the motor to the output spindle. The light system includes a light ring and a circuit assembly. The circuit assembly includes a light emitting element and is received in the light ring. The light ring is received axially between the first and second case members.

In another form, the present disclosure provides a power tool that includes an output spindle, a motor that provides a source of rotary power, a transmission drivingly coupling the motor to the output spindle, an end effector coupled to the output spindle for movement therewith, a housing into which the output spindle, the motor and the transmission are received, a generator and a light coupled to the generator for receipt of electrical power therefrom. The generator includes a field winding and a set of magnets. The field winding is coupled for rotation with a first one of an output shaft of the motor, a first rotating component of or driven by the transmission, a second rotating component of or driven by the transmission, the output spindle and the end effector such that the field winding rotates at a first rotational speed when the motor is operating. The set of magnets is coupled for rotation with a second, different one of the output shaft of the motor, the first rotating component of or driven by the transmission, the second rotating component of or driven by the transmission, the output spindle and the end effector such that the set of magnets rotates at a second rotational speed when the motor is operating. The second rotational speed is different from the first rotational speed such that an electric current is produced in the field winding.

Optionally, the power tool can be further characterized by one or more of the following:

the field winding can be mounted on the first rotating component, the set of magnets can be mounted on the second rotating component, and the first and second rotating components can be planet carriers in adjacent stages of the transmission;

the set of magnets can be mounted on the first rotating component and the field winding can be mounted on the output spindle;

the first rotating component can be a sun gear;

one of the field winding and the set of magnets can be mounted on a drive shaft that is directly coupled to the output shaft of the motor and the field winding can be located within the end effector;

one of the field winding and the set of magnets can be mounted on a drive shaft that is directly coupled the first component and the field winding can be located within the end effector;

the field winding can be received coaxially within the set of magnets; the set of magnets can be received within the field winding and the set of magnets can include a plurality of magnets that are spaced axially apart along a rotational axis about which the set of magnets rotate; and

the power tool can include an energy storage device that is electrically coupled to the generator and the light, the energy storage device can be a capacitor, and the energy storage device can be housed in the end effector.

In still another form, the present disclosure provides a power tool that includes an output spindle, a motor providing a source of rotary power, a transmission drivingly coupling the motor to the output spindle, an end effector coupled to the output spindle for movement therewith, a housing into which the output spindle, the motor and the transmission are received, and a light system that includes a first portion and a second portion. The first portion is coupled to the housing and includes a pair of first terminals that are configured to be coupled to a source of electric power. The second portion is mounted to the end effector for common rotation about an axis. The second portion includes a connector and a circuit assembly. The connector includes a pair of second terminals that are configured to engage the pair of first terminals to conduct electricity between the first and second portions. The circuit assembly includes a light element that is electrically coupled to the pair of second terminals.

Optionally, the power tool can be further characterized by one or more of the following:

the light system further includes a transparent cover that is mounted to the end effector on a side of the circuit assembly opposite the connector;

the cover includes an optic element, the optic element being configured to either spread light generated by the light emitting element or focus light generated by the light emitting element;

the end effector is a chuck; and

one of the pair of first terminals and the pair of second terminals includes annular conductive members disposed concentrically about the axis.

In accordance with one embodiment of the present invention, a power tool is provided. The power tool includes a housing, an end effector rotatable with respect to the housing, a collar rotatable with respect to the housing, a printed circuit board (PCB) rotatably fixed with respect to the housing, and a lighting element operatively connected to the PCB and adjacent to the end effector and in a recess of the collar and located to illuminate a workpiece machined by the power tool.

In accordance with another embodiment of the present invention, a power tool is provided. The power tool includes a rotatable end effector, a rotatable collar, a printed circuit board (PCB), lighting elements operatively connected to the PCB and adjacent to the end effector and located to illuminate a workpiece machined by the power tool, and a guide supporting the PCB and wires configured to provide power to the PCB for illuminating the lighting elements, wherein the PCB and a portion of the guide are generally circular in shape, the lighting elements are annularly arranged on the PCB and portion of the end effector extends through a hole in the defined by the guide and PCB and the guide defines a groove and the PCB is located in the groove.

In accordance with yet another embodiment of the present invention, a method of providing light for a workpiece being machined by a power tool is provided. The method includes locating lighting elements around a spindle of a power tool, aligning the lighting elements to shine light on a workpiece being machined by the power tool, operatively connecting the lighting elements to a PCB, containing and supporting the PCB with a guide, supporting wires configured to provide power to the PCB with the guide, locating the lighting elements, PCB and guide in a rotatable collar, and preventing the lighting elements, PCB and guide from rotating when the collar rotates.

Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this summary are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

FIG. **1** is a side view illustrating a power tool in accordance with an embodiment of the invention.

FIG. **2** is a perspective view illustrating a front portion of a power tool in accordance with an embodiment of the invention.

FIG. **3** is a perspective close-up view of the power tool of FIG. **2** with the end effector removed in order to more distinctly show surrounding elements.

FIG. **4** is a perspective view similar to that shown in FIG. **3** with a retaining ring removed in order to more clearly show surrounding elements.

FIG. **5** is a perspective view of a wire guide and printed circuit board (PCB) having light emitting diode (LED) elements.

FIG. **6** is a partial perspective view of a bottom portion of the wire guide and PCB.

FIG. **7** is a perspective view of the PCB and wires with the wire guide removed.

FIG. **8** is a partial perspective rear view of the wire guide, PCB, and wires.

FIG. **9** is a partial exploded perspective view of the wire guide and a power tool having some elements removed to better show other elements.

FIG. **10** is a partial perspective view of a wire guide, clutch adjusting nut, clutch spring, and clutch washer mounted on the wire guide.

FIG. **11** is a partial perspective view of a power tool and clutch collar where the clutch collar is shown in a forward position to illustrate the clutch adjusting nut, clutch spring, and clutch washer mounted to the nose cone.

FIG. **12** is a partial rear perspective view of the wire guide mounted on the clutch collar.

FIG. **13** is a partial perspective view of the wire guide mounted onto the nose cone.

FIG. **14** is a partial cutaway perspective view of a nose cone as well as other elements mounted to the nose cone. The end effector and power transmission elements are removed for clarity.

FIG. **15** is a perspective rear view of a holder in accordance with another embodiment of the invention.

FIG. **16** is a partial perspective view of a power tool equipped with a holder similar to that shown in FIG. **15**.

FIG. **17** is a partial perspective view with part of the housing removed of a power tool equipped with a holder similar to that shown in FIG. **15**.

FIG. **18** is a partial perspective view of a power tool with part of the housing removed to expose interior components.

FIG. **19** is a partial perspective cut-away view of a power tool equipped with a holder similar to that shown in FIG. **15**. The cut-away view illustrates some of the internal components of the power tool.

FIG. **20** is a perspective view of another power tool constructed in accordance with the teachings of the present disclosure.

FIG. **21** is a longitudinal section view of a portion of the power tool of FIG. **20**.

FIG. **22** is a partially exploded perspective view of the power tool of FIG. **20**.

FIG. **23** is a rear elevation view of a portion of the power tool of FIG. **20**, illustrating a portion of a light ring in more detail prior to the deformation of a plurality of tabs on a holder.

FIG. **24** is an enlarged perspective view of a portion of the light ring illustrated in FIG. **23**.

FIG. **25** is an enlarged perspective view of a portion of the light ring shown after the plurality of tabs on the holder have been deformed to retain a circuit board to the holder.

FIG. **26** is a perspective view of a portion of the power tool of FIG. **20**, illustrating a cover associated with a gear case.

FIG. **27** is a perspective view of a portion of another power tool constructed in accordance with the teachings of the present disclosure.

FIG. **28** is an exploded perspective view of a portion of the power tool of FIG. **27**.

FIG. **29** is a longitudinal cross-sectional view of a portion of the power tool of FIG. **27**.

FIG. **30** is a perspective, partially sectioned view of a portion of yet another power tool constructed in accordance with the teachings of the present disclosure.

FIG. **31** is a perspective, partially sectioned view of a portion of the power tool of FIG. **30**, illustrating an output spindle and a field winding in more detail.

FIG. **32** is a perspective, partially sectioned view of a portion of the power tool of FIG. **30**, illustrating a sun gear and a set of magnets in more detail.

FIG. **33** is a perspective view of a portion of another power tool constructed in accordance with the teachings of the present disclosure.

FIG. **34** is a schematic illustration of another power tool constructed in accordance with the teachings of the present disclosure.

FIG. **35** is an enlarged portion of FIG. **34**, illustrating the set of magnets and the field winding positioned within the chuck.

FIG. **36** is a schematic illustration of an alternative manner of mounting the set of magnets to the drive shaft.

FIG. **37** is a schematic illustration of another power tool constructed in accordance with the teachings of the present disclosure.

Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

The invention will now be described with reference to the drawing figures, in which like reference numerals refer to like parts throughout. An embodiment in accordance with the present invention provides a power tool having a light ring configured to shine light onto a workpiece being operated upon by the power tool.

According to some embodiments of the invention, light emitting elements, such as light emitting diodes (LEDs), are placed in an annular or ring shape around part of the end effector and are configured to shine forward to illuminate the tool or accessory held by the end effector and the workpiece being machined by the tool. The end effector may be a tool or accessory holder mounted to an output spindle of the tool. Examples of end effectors that may be used in accordance with the invention may be the 7000 Series chuck manufactured and marketed by the Jacobs Chuck Manufacturing Company of Clemson, S.C. and quick change chucks and bit holders similar to those which are found on products such as a DC825KA Impact Driver and the driver that is disclosed in U.S. application Ser. No. 12/394,426 (the disclosure of which is incorporated by reference as if fully set forth in detail herein) and a DC815KA Impact Driver that are manufactured and marketed by the DeWalt Industrial Tool Company of Baltimore, Md.

While several different types of lighting elements can be used in accordance with the invention, such as light bulbs (for example, xenon bulbs) or other lighting elements, LED lights are discussed here as an example and do not limit embodiments in accordance with the invention to tools using LEDs. The LED lights, or other lighting elements, and associated parts are locked to the housing of the tool and do not rotate when the power tool is operated. The lights may be powered by the same power source that provides power to the power tool's motor. In the case of most cordless power tools, it is a battery that powers the power tool and in the case of corded tools it is AC current provided from source voltage through a cord. This AC current may be modified according to the needs of the lighting device being employed. In the case of LED lights, a rectifer may be employed to convert AC current to DC.

An embodiment in accordance with the invention is illustrated in FIG. **1**. FIG. **1** shows a power driver **20**. The power driver **20** has a housing **22**. The housing may be of a clam shell type or any other suitable type housing. The power driver **20** may have a nose cone **23** located at the front portion of the power driver **20**. A handle **24** projects downwardly from the housing **22** and is terminated with a battery **26**. The battery **26** provides the power to turn the end effector **28**.

The end effector **28** may be configured to hold an accessory or tool such as a drill bit or a driving type accessory such as a Philips or standard screwdriver. Other types of tools or accessories may be held and used in the end effector **28** as can appreciated by one skilled in the art. The movement of the end effector **28** may be controlled by the trigger **30**. The trigger **30** may selectively provide power from the battery **26** to the motor **32** located within the housing **22**. In some embodiments of the invention, the more the trigger or switch **30** is depressed the more power may be applied to the motor **32** which may cause the end effector **28** to spin faster.

The power driver **20** may be equipped with a clutch collar **34**. Other embodiments in accordance with the invention may not have a rotating clutch collar, but rather a different rotating collar mechanism. The rotating collar mechanism may be a drill/hammer mode selector, a gear shifter, an on/off switch, a tool variable speed control or other rotating collar control mechanism. However, this specification will refer to a clutch collar as an example but does not limit embodiments in accordance with the invention to tools having clutch collars. The clutch collar **34** can provide protection for interior portions of the power driver **20**, particularly the transmission and other internal components of the power driver **20** that may be mounted on the nose cone **23**. The clutch collar **34** may be rotated to adjust the transmission. An example of a clutch and transmission that may work in accordance with the invention is shown in U.S. Pat. No. 7,066,691 which is incorporated by reference in its entirety. Of course, most any type of clutch and transmission may be used in accordance with the invention. Different angular positions of the clutch collar **34** may provide different amounts of torque and/or speed to the end effector **28** for a given trigger **30** position. A numbered scale **36** may appear on the clutch collar **34** in order to provide a user an indication of the setting of the clutch collar **34**. In some embodiments the user may turn the clutch collar **34** to a desired position by hand.

A light ring **38** is located on a front portion of the power tool **20** just behind the end effector **28** in a recess **39** in the clutch collar **34**.

In FIG. **2**, a partial perspective view of a front portion of the power driver **20** is shown. An indicator **37** may be located on the nose cone **23**. The indicator **37** may provide a reference for the user for determining the angular position of the clutch collar **34** and a reference point for comparing the numbers on the numbered scale **36**. The light ring **38** is located within a recess **39** of the clutch collar **34**. The light ring **38** may include a cover **40**. The cover **40** may protect interior components of the tool from moisture or other contaminants. The cover **40** may include blisters **42** located on the cover **40** as to be directly over the LEDs **58** (as shown in FIG. **5**). The blisters **42** may be translucent or clear in order to permit light generated by the LEDs **58** to pass through. In some embodiments the blisters **42** may direct or focus the light. The blisters **42** may be round, rectangular, square or any other shape. In some embodiments the blisters **42** are shaped to correspond with the shape of the lighting elements **58**. In other embodiments

the light may simply pass through the blisters **42**. The remainder of the cover **40** may be a dark color. Other color schemes may be used in accordance with the invention.

The cover **40** is held axially in place from moving in a forward direction toward the end effector **28** by retaining ring **44**. The retaining ring **44** is mounted on a retainer **46** which is part of the nose cone **37** as better illustrated in FIGS. **13** and **14** and described in more detail later below.

FIG. **3** is a similar view to that shown in FIG. **2**, however, the end effector **28** is removed to better illustrate certain features associated with the retaining ring **44** and the retainer **46**. FIG. **3** shows portions **48** of the retaining ring **44** exposed in gap **50** that would fit within the groove **52** if it were not in the gap **50**. The retaining ring **44** fits within a groove **52** in the retainer **46**. When the retaining ring **44** is placed in the groove **52** the retaining ring **44** is secured in place. The retaining ring **44** prevents the cover **40** from axially moving forward toward the end effector **28**.

FIG. **4** is a similar view as that shown in FIG. **3**, however, the retaining ring **44** has been removed as well as the end effector **28** to better illustrate features of the cover **40** and the retainer **46**. The cover **40** includes tabs **56**, which are located within the gaps **50** of the retainer **46**. The tab **56** and gap **50** combination keep the cover **40** aligned and from rotating around the retainer **46**. The groove **52** is also illustrated in FIG. **4** in which the retaining ring **44** is located as shown in FIG. **3**.

FIG. **5** illustrates other aspects of the light ring **38**, which are normally contained within the clutch collar **34** and located behind the cover **40**. As part of the light ring **38**, light emitting diodes or LEDs **58** are located at various points around the light ring **38**. In some embodiments in accordance with the invention, the LEDs **58** emit white light although in other embodiments the LEDs **58** might emit other colors of light. In some embodiments different LEDs on the same tool could emit different colors of light. While the embodiment shown in FIG. **5** illustrates three LEDs **58** any number of LEDs may be used in accordance with the invention including one or more.

The LEDs **58** are mounted to a ring-shaped printed circuit board or PCB **60**. The PCB **60** and LEDs **58** are fit into a trench **61** in the wire way **62**. The wire way **62** and trench **61** may allow for potting of the PCB if necessary. The wire way **62** provides protection and structural strength for the PCB so that undue mechanical loads are not placed upon the PCB **60**. Such support is desirable as a PCB **60** may be fragile and subject to breaking or malfunctioning. The wire way **62** may include snap-in features **64** which allow the PCB **60** to be pushed into the wire way **62** and then the snap-in features **64** snap out once the PCB **60** is located within the wire way **62**. The snap-in features **64** prevent the PCB **60** from coming out of the wire way **62**.

The wire way **62** may include grooves **66**. Tabs **68** located on the PCB **62** may fit within the grooves **66** within the wire way **62**. The tabs **68** and grooves **66** combination help the PCB **60** and the wire way **62** be aligned and may prevent or resist the PCB **60** from rotating with respect to the wire way **62**.

The wire way **62** may include a PCB holding portion **70** which is generally circular in shape and a wire supporting portion **72**. The wire supporting portion **72** may include a channel **74** which is sized and located to contain wires **76**. The wires **76** may provide power to the PCB **60** which in turns provides power to illuminate the LEDs **58**. The wire supporting portion **72** of the wire way **62** provides a structure for the wires **76** to be supported in and provides protection for the wires **76**. The wires **76** may terminate with a plug **78**. The plug **78** may fit into plug supporting structure **80** located within the wire supporting portion **72** so that the plug **78**, which is made of a more rigid material than the wires **76**, is held securely to the wire way **62** via the plug supporting structure **80**. In some embodiments, the plug **78** may be press fit into the wire supporting portion **72** of the wire way **62**. The circuit to which the PCB **60** is connected may also include an electromagnetic surge suppression circuit (such as a zener diode) for static and over-voltage protection. The circuit may also include a resistor or resistors to drop the voltage from the battery pack voltage to an appropriate level for the LEDs.

Some embodiments do not have a separate PCB, wire guide, wires and connector. For example, plated plastics can be used whereby the wire guide could be first molded into a shape similar to the wire guide **62** as shown. Secondly, tracks (like on a standard PCB) could be created on this plastic piece, and could include all of the pads to mount LEDs and other components, the tracks, or "wires," from the front of the tool back to the connector area, and could even include the male end of the connector. The components (diodes, resistors, etc.) could then be soldered to this one piece, and would be electrically connected back to the place where the wires would connect it to the switch. This would greatly simplify the assembly.

FIG. **6** is a partial perspective view of a bottom portion of the wire way **62**. The wire way **62** may be equipped with a collar stopping tab **82** which will be explained in more detail below as FIG. **12** is discussed.

FIG. **7** is a perspective view similar to that shown in FIG. **5**, however, the wire way **62** has been removed in order to better illustrate some of the features shown in FIG. **7**. The LEDs **58** are mounted onto the PCB **60**. The PCB **60** shows the tabs **68**. While the embodiments shown in the figures show five tabs **68**, one skilled in the art can appreciate that other numbers of tabs or other features may be employed in order to help keep the PCB aligned and/or rotationally locked to the wire way **68**.

The wires **76** are attached to a rear portion of the PCB **60**. The plug **78** includes the plug stopping structure **84** which butts against a portion of the wire way **68** to prevent the plug **78** from being inserted too far into the wire way **62**.

FIG. **8** illustrates the plug stopping structure **84** located on the plug **78** butted against the wire supporting portion **72** of the wire way **62**. The wires **76** are located within the channel **74**. In some embodiments, the plug **78** snaps into the wire supporting portion **72** and the wires **76** may be pressed into the channel **74** in a press fit manner to secure the wires **76** into the channel **74**. A rear portion of the collar stopping tab **82** is also illustrated in FIG. **8**.

FIG. **9** illustrates the housing **22** and the wire way **62**. The nose cone **23** has been removed in order to better illustrate how the plug **78** attaches to a receiving plug **86**. The plug **78** is slid into the receiving plug **76**. The plug stopping structure **84** slides into slots **87** located on the receiving plug **86**. Once the plug **78** and the receiving plug **86** have been mated together, power from the wires **88** is communicated to the wire **76**. The joint made of the plug **78** and the receiving plug **86** provide a rigid support for the connection of the wires **76** and **88**. The wires **88** may receive power from the battery **26** as controlled by the trigger **30**. In some embodiments the wires **88** extend out of a switch body associated with the trigger **30**. In other embodiments, a switch body could have connectors to which the wires **88** are soldered or otherwise connected. The trigger switch may include electronics for variable speed control. The wires **88** may be soldered to a PCB located inside the switch body.

In accordance with some embodiments of the invention, when the trigger **30**, as shown in FIG. **1**, is depressed, power is sent to the wires **88** and in turn **76** to illuminate the LEDs.

FIG. **10** is a partial perspective view of the guide **62** showing several additional elements on the guide **62**. A clutch adjusting nut **90** is butted against the guide **62**. The stop tab **82** is fit into a notch **92** in the clutch adjusting nut **90**. The notch **92** in the clutch adjusting nut **90** aligns to the stopping tab **82** on the guide **62** to assist in providing proper assembly of the threads between the adjusting nut **90** and the nose cone **23** during assembly. In some embodiments and as shown in FIG. **10**, the notch **92** and the clutch adjusting nut **90** may have chamfered edges **96** to the notch walls **94**. The chamfered edges **96** may assist in the stopping tab **82** to be seated in the notch **92** and the clutch adjusting nut **90**.

According to some embodiments, a combination of the notch **92** and the clutch adjusting nut **70** and the stopping tab **82** in combination with the other tabs and notch combinations **50**, **56**, **66**, **68** can assure that the cover **40**, the nose cone **23**, the wire way **62**, the PCB **60**, and the clutch adjusting nut **90** are aligned with respect to each other.

The clutch adjusting nut **90** includes a ridge **100**. As shown in FIG. **10** a clutch spring **102** urges at one end against the ridge **100** and at the opposite end of the clutch spring **102**, the clutch spring **102** urges against a clutch washer **104**. The clutch spring **102** exerts a force on the ridge **100** of the clutch adjusting nut **90** which in turn urges the wire way **62** against the cover **40** and ultimately against the retaining ring **44**. The force exerted by the clutch spring **102** keeps the light ring assembly **38** in axial position. As shown in FIG. **11** the clutch washer **104** urges against the nose cone **23**.

FIG. **11** illustrates the clutch washer **104**, clutch spring **102**, and the clutch adjusting nut **90** mounted to the nose cone **23**. The clutch collar **34** is shown in a forward axial position and not yet installed on the power tool **20** in order to expose the clutch washer **104**, the clutch spring **102** and the clutch adjusting nut **90**.

To provide ease in the assembly of the power tool **20**, a tab **98** on the clutch adjusting nut **90** is scored with marks or notches **106** on one of the adjustment tabs **98**. The scoring **106** provides a visual aid when assembling the collar **34** to properly align the clutch collar **34**. The adjustment tab **98** on the clutch adjusting nut **90** is aligned with a desired notch **108** in the clutch collar **34**. Once the desired notch **108** is aligned with the desired adjustment tab **98**, the clutch collar **34** can be fitted onto the power tool **20**. In some embodiments, the indicator **34** and the numbered scale **36** may also provide assistance in aligning the clutch collar **34** to provide proper assembly of the clutch collar **34** onto the nose cone **23**.

FIG. **12** is a partial perspective view of the clutch collar **34** installed onto the guide **62**. Other elements have been omitted from FIG. **12** in order to better show the interaction between the guide **62** and the clutch collar **34**. The clutch collar **34**, in some embodiments in accordance with the invention, is rotatable. The clutch collar **34** is rotatable on the power tool **20** in order to provide different torque and/or speed settings for the end effector **28**. It may be desirable to limit the rotation of the clutch collar **34** in both directions to establish a maximum setting for turning the clutch collar clockwise and a maximum setting when turning the clutch collar counterclockwise as shown in FIG. **12**. Making maximum and minimum settings is, in some embodiments, accomplished by using the collar stopping tab **82** which butts against the stop **110** on the clutch collar **34**. The wall **112** on the stop **110** butts against a wall **114** on the collar stopping tab **82** to provide a limit to clutch collar **34** rotation in a clockwise direction as viewed in FIG. **12**. The same stop **110** and collar stopping tab **82** provide a stop for rotating the clutch collar **34** in the opposite direction (i.e., counterclockwise as viewed in FIG. **12**). This is accomplished when the clutch collar **34** is rotated so that the opposite wall **116** on the stop **110** butts against the opposite wall **118** on the tab **82**.

FIG. **12** also illustrates additional notches **108** in the clutch collar **34** for providing detents when the clutch collar **34** is rotated to various settings with respect to the nose cone **23**.

FIG. **13** is a partial perspective view of the guide **62** mounted onto a stem portion **120** of the nose cone **23**. A lock portion **124** of the guide **62** fits into a groove **122** of the stem portion **120** of the nose cone **23**. The groove **122** is sized and dimensioned so that the lock portion **124** of the wire supporting portion **72** of the guide **62** fits within the groove **122** and locks the guide **62** to be angularly fixed with respect to the nose cone **23**. The locks **124** located on the wire supporting portion **72** of the guide **62** are wider than the rest of the wire supporting portion **72** and aid in permitting the guide **62** to be securely seated in the groove **122** of the stem portion **120** of the nose cone **23**.

A second groove **126** is in the nose cone **23** for allowing the wire supporting portion **72** of the guide **62** to fit within the groove **126** of the nose cone **23**. The retainer **46** on the nose cone **23** and the groove **52** of the nose cone **23** are also shown forward of the guide **62**. The above described features also help align the guide **62** with respect to the nose cone **23**.

According to some embodiments, the retainer **46** is integral with the stem **120** and the nose cone **23**. In other embodiments of the inventions, they may be separable parts.

FIG. **14** is a partial cutaway perspective view of the nose cone **23** and additional parts described below. FIG. **14** shows how the parts described herein are assembled together according to some embodiments of the invention. The transmission, spindle, and other parts associated with turning the end effector have been omitted to more clearly show the parts described herein. The retaining ring **44** is seated within the groove **52** of the retainer **46**. The retaining ring **44** provides a limit of forward axial movement of the cover **40**, the guide **62**, and the clutch adjusting nut **90**. The clutch spring **102** presses against the clutch washer **104** to urge the clutch adjusting nut **90** to urge the guide **62**, PCB **60**, and cover **40** against the retaining ring **44**. The wires **76** are located in a channel **74** defined by the guide **62** and the nose cone **23**. The wires **76** are protected from the spinning parts of the end effector mechanism.

Although an example of the light ring **38** is shown on a power driver **20**, it will be appreciated that the light ring **38** can be used on other rotary power tools such as impact drivers, drills, hammer drills, routers.

An example embodiment in accordance with the invention where a light ring **38** is mounted on a different power tool than shown in the previous FIGS. is shown in FIGS. **15** through **19**. FIG. **15** illustrates a perspective rear view of a holder **140** that is used on a power tool that is not equipped with a collar as described in the embodiments above. The holder **140** holds the light ring **38**. The light ring **38** includes the PCB **60** similar to that described above. The PCB **60** and the holder **140** may include snap-in features **64** similar to that described above so that the PCB **60** snaps into and is secured in the holder **140**.

A circular cover **40** may be mounted to the holder **140** in front of the PCB **60** similar to embodiments described above. The cover **40** may include snap-in elements that correspond with snap-in elements on the holder **140**. In other embodiments in accordance with the invention, the lens **40** may be secured in place with a retaining ring system similar to that described above.

The holder **140** may attach to the nose cone **23** with snap-in elements located on both the holder **140** and the nose ring **23** similar to the snap-in features **64** described in the embodiments above. In other embodiments in accordance with the invention, the light ring holder **140** may be secured in place in a variety of ways including, but not limited to, a retaining ring system similar to the embodiments described above.

As shown in FIG. **15**, the holder **140** includes a housing portion **142**, a chin shroud **144**, and a wire way portion **146**. Wires **76** connect the PCB **60** (which contains light emitting elements similar to those described above) with a plug **78**. In contrast to the wire way **62** described in the embodiments above, the holder **140** does not fully support the wires **76** along the full length of the wires **76** all the way to the plug **78**. Rather, the wire way portion **146** stops at some point along the length of the wires **76**, leaving the wires **76** and the plug **78** to be not supported by the holder **140**.

FIG. **16** is a partial perspective view of a power tool **147** that does not have a rotatable clutch collar but rather is equipped with the holder **140**. The cover **40** is shown mounted in a recess in the holder **140**. The holder **140** is mounted to the nose cone **23** which is supported by the housing **22**. A fastener hole **148** is shown in the housing **22**. The fastener hole **148** provides a place for a fastener such as a screw or bolt to connect the two halves of the clam shell type housing **22** together. While the fastener is not shown in FIG. **16**, it will be appreciated that when the power tool **147** is fully constructed that a fastener will be located in the fastener hole **148** to connect the two halves of the clam shell housing **22** together. Other embodiments of the invention may connect the clam-shells of the housing **22** in other ways. Some embodiments of the invention may include one piece housings or other types of housings than the clam shell housing shown in FIG. **16**. The chin shroud **144** is located on the holder **140** and provides a housing for a portion of the wires **76** so that the wires **76** are not exposed outside of the power tool **147**.

FIGS. **17** and **18** show the power tool **147** with part of the housing **22** removed. The housing **22** is a clam shell type housing and one of the clam shells is removed exposing the clam shell housing **22** located on the far side of the power tool **147**. The holder **140** is shown mounted to the nose cone **23**. A fastener hole tube **150** located in the fastener hole **148** is shown. The wires **76** are routed around the hole tube **150** and are located in the interior **152** of the housing **22**. The wires **76** are terminated with a plug **78** also located in the interior **152** of the housing **22**.

The interior **152** of the housing defines a space or pathway for the wires **76** and the plug **78**. The chin shroud **144** defines a wire way portion **146** through which the wires **76** are strung. The chin shroud **144** also includes retaining structure **154** which is set in a retaining area **156** defined by the housing **22**. When the two clam shells of the clam shell housing **22** are mounted together and fastened together with a fastener located in the fastener hole **148** and fastener hole tube **150**, the retaining structure **154** on the chin shroud **144** is trapped in the retaining area **156** thereby holding the chin shroud **144** and holder **140** in place on the power tool **147**. Operation of the light ring **38** is similar to that described in the embodiments above.

FIG. **19** is a partial perspective cut-away view showing the end effector **28** associated with the power tool **147** extending through the cover **40** located in front of the PCB **60**. As described above, LEDs (not shown in FIG. **19**) are located on the PCB **60** and configured to light the tool or workpiece being worked on by the power tool **147**. The wires **76** provide power between the PCB **60** and a power source connected via the plug **78** to power source. The wires **76** are located in the wire way portion **146** of the chin shroud **144** and the interior **152** of the housing **22**. The chin shroud **144** has the retaining structure **154** located in the retaining area **156** defined by the housing **22**.

While the driver **20** (FIG. **1**) has been illustrated and described herein as including a lighting system that is disposed between a gear case and a rotating collar **34** (FIG. **1**) of the driver **20** (FIG. **1**) and/or forwardly of a housing **22** (FIG. **1**) and/or a gear case or nose cone **23** (FIG. **1**), it will be appreciated that the driver could be constructed somewhat differently. With reference to FIGS. **20** through **22**, for example, another driver constructed in accordance with the teachings of the present disclosure is generally indicated by reference numeral **400**. The driver **400** can include a housing assembly **22***a*, a motor **402**, a transmission **404**, an output spindle **406**, a battery pack **408** and a lighting system **410**. In the particular example provided, the driver **400** is depicted as being an impact driver that operates the output spindle **406** in a rotary manner similar to that which is disclosed in U.S. application Ser. No. 12/769,981, the disclosure of which is incorporated by reference as if fully set forth in detail herein. Those of skill in the art will appreciate that the driver **400** could be configured as a screwdriver, drill driver, hammer drill driver, and/or rotary hammer to provide a rotary and/or axial output or could be configured to provide an axial output (e.g., hammer).

The housing assembly **22***a* can be configured to house the motor **402**, the transmission **404** and at least a portion of the output spindle **406**. In the example provided, the housing assembly **22***a* includes a clam shell housing **416**, which is formed by a pair of clam shell halves, and a gear case assembly **418** that includes a first gear case member **420**, a second gear case member **422**, and a cover **424**.

The first gear case member **420** can define a first case portion **430** and a second case portion **432**. The first case portion **430** can be mounted to the clam shell housing **416** and extend forwardly therefrom. The first case portion **430** can define an internal cavity **436** into which the transmission **404** can be received. The second case portion **432** can be coupled to or integrally formed with the first case portion **430** and can extend forwardly therefrom. The second case portion **432** can define a spindle aperture **440** and a mounting boss **442**. The spindle aperture **440** can intersect the internal cavity **436** to define a passageway through which the output spindle can be received.

The second gear case member **422** can define a bearing mount **450** and one or more through-holes **452**. The bearing mount **450** can be configured to receive a spindle support bearing **454** therein. The second gear case member **422** can be received on the mounting boss **442** and can be secured thereto via a plurality of fasteners **456**. It will be appreciated that the mounting boss **442** is configured to align the spindle support bearing **454** to the rotational axis **460** of the output spindle **406**.

The motor **402**, the battery pack **408** and the transmission **404** can be conventional in their construction and operation. Briefly, the motor **402** can be housed in the clam shell housing **416** and can be electrically coupled to the battery pack **408** through a trigger (switch) **30***a*. The battery pack **408** can be releasably coupled to the clam shell housing **416**. The transmission **404** can be any type of transmission, such as a multi-stage planetary transmission, and can have an input member, that can be driven by an output shaft **464** of the motor **402**, and an output member that can be drivingly coupled to the output spindle **406**. In the particular example provided, the transmission **404** includes a single stage planetary reduction **470** and a Potts-type impact mechanism **472**. A sun gear **474** associ-

ated with the planetary reduction **470** serves as the transmission input, while a planet carrier **476** associated with the planetary reduction serves as an output of the planetary reduction **470**. The impact mechanism **472** can include an input spindle **480**, which can receive rotary power from the planet carrier **476**, a hammer **482**, which can be mounted on the input spindle **480**, a cam mechanism (not specifically shown), an impact spring **486** and an anvil **488**. The cam mechanism can couple the hammer **482** to the input spindle **480** in a manner that permits limited rotational and axial movement of the hammer **482** relative to the input spindle **480**. The impact spring **486** can bias the hammer **482** into a position where the cam mechanism rotatably couples the hammer **482** to the input spindle **480**. The anvil **488**, which can be mounted for rotation on the input spindle **480**, is configured to engage the hammer **482** such that rotational energy in the hammer **482** can be transmitted to the anvil **488**.

The output spindle **406** can be integrally formed with the anvil **488** and can have a shaft member **490**, a chuck portion **492**, and a journal portion **494** that can be disposed on a side of the chuck portion **492** opposite the shaft member **490**. The shaft member **490** can be supported for rotation about the rotational axis **460** by a bushing **500** that is disposed in the first case portion **430** of the first gear case member **420**. The chuck portion **492** can be disposed forwardly of the first gear case member **420** and can be configured to receive a tool bit, such as a ¼ inch hex bit, therein. The journal portion **494** can be a distal end of the output spindle **406** and can be received in the spindle support bearing **454** in the second gear case member **422** such that the end of the output spindle **406** opposite the input spindle **480** is journally supported by the second gear case member **422**.

The lighting system **410** can include a light ring **38***a* and a circuit assembly **510**.

The light ring **38***a* can comprise a holder **140***a* and a wireway **62***a*. The holder **140***a* can be formed in a generally semi-annular (e.g., horseshoe) shape that is configured to be mounted about a portion of the mechanism that unlatches the chuck or bit holder, as well as be matingly received on the mounting boss **442** of the first gear case member **420** such that the light ring **38***a* is rotationally fixed to the housing assembly **22***a*. The holder **140***b* can define a trench **61***a*, which can be configured to receive the circuit assembly **510**, and a plurality of LED apertures **520** that can extend axially through the holder **140***a* in-line with the through-holes **452** in the second gear case member **422**. The wireway **62***a* can define a wire channel **524**, as well as an operator mount **526** that can be configured to receive there through an axially movable button **528** that can be employed to unlatch the bit holder C. The button **528** can be coupled to a lever **530**, which is fitted to a bit holder sleeve **532**, and can be biased outwardly from the clam shell housing **416** via a button spring **534**. The bit holder sleeve **532** can be axially movably mounted on the chuck portion **492** of the output spindle **406** between a first or latched position, in which a locking ball **538** is urged radially inwardly into the hollow interior of the chuck portion **492**, and a second or unlatched position in which the locking ball **538** may be moved radially outwardly so that a tool bit received in the chuck portion **492** can be withdrawn from the output spindle **406**. The wireway **62***a* can effectively close an opening about the button **528** between the gear case assembly **418** and the clam shell housing **416**.

The circuit assembly **510** can include a circuit board **60***a*, a plurality of LED's **58***a* and a wire harness **550**. The circuit board **60***a* can be formed of an insulating material and can include wires or conductors (not specifically shown) that can electrically couple the wire harness **550** and the LED's **58***a*. In the particular example provided, the circuit board **60***a* is a printed circuit board that is formed in a semi-annular shape that is configured to be received in the correspondingly shaped trench **61***a* formed in the light ring **38***a*. The LED's **58***a* can be fixedly coupled to the circuit board **60***a* and can be disposed in-line with the LED apertures **520** formed in the light ring **38***a*. If desired, the LED's **58***a* can extend into or through the LED apertures **520**. The wire harness **550** can comprise a plurality of wires **76***a* and a plug **78***a*. The wires **76***a* can include first and second wires (not specifically shown) that can be coupled to the conductors of the circuit board **60***a* and to the conductors (not specifically shown) in the plug **78***a* to transmit electrical power between the plug **78***a* and the LED's **58***a*. The wires **76***a* can be received in the wireway **62***a* in the light ring **38***a* and can be festooned or routed through a wire channel **524** formed in the clam shell housing **416**. The plug **78***a* can be configured to matingly engage a corresponding plug (not specifically shown) to electrically couple the circuit assembly **510** to a source of electrical power. In the particular example provided, the corresponding plug is electrically coupled to a trigger **30***a* that is coupled to the battery pack **408**. The trigger **30***a* can be configured to transmit electrical power from the battery pack **408** to the circuit assembly **510** in a desired manner, such as during operation of the motor **402**, or during operation of the motor **402**, as well as for a predetermined amount of time after operation of the motor **402**.

The circuit assembly **510** can be coupled to the light ring **38***a* in any desired manner, including adhesives, potting compounds, clips and fasteners. In the particular example provided, the light ring **38***a* comprises a plurality of retaining tabs **560** that can extend through tab apertures **562** in the circuit board **60***a*. With additional reference to FIGS. **23** and **24**, the tabs **560** can be initially formed to extend in an axial direction that is generally parallel to the rotational axis **460** of the output spindle **406**, which can facilitate the axial translation of the circuit board **60***a* into the trench **61***a*, and can be deformed in whole or in part to retain the circuit board **60***a* within the trench **61***a*. The tabs **560** can be deformed by twisting or bending, but in the example provided, each of the tabs **560** is heated and bent over at a right angle as shown in FIG. **25** so as to lie over a portion of the circuit board **60***a* adjacent a corresponding one of the tab apertures **562**.

With renewed reference to FIGS. **20** through **22** and additional reference to FIG. **26**, the cover **424** can be fixedly coupled to the second gear case member **422** in any desired manner, such as via mating sets of ribs and grooves **590**. It will be appreciated that mating features (not specifically shown) may be formed into the cover **424** and the second gear case member **422** that inhibit rotation of the cover **424** relative to the second gear case member **422** when the cover **424** is engaged to the second gear case member **422**. The cover **424** can define a set of second through-holes **592**, as well as a button stop **594**. The set of second through-holes **592** can be disposed in-line with the through-holes **452** in the second gear case member **422** and the LED's **58***a* in the circuit assembly **510** such that light generated by the LED's **58***a* can be transmitted through the second gear case member **422** and the cover **424** to illuminate an area forwardly of the gear case assembly **418** and the output spindle **406**. The button stop **594** can be disposed forwardly of the button **528** and can be employed to limit forward axial movement of the button **528**.

It will be appreciated that if desired, various devices (not shown), such as lenses and/or diffusers, may be incorporated into the driver **400**. For example, such devices may be located

in one or both of the through-holes **452** in the second gear case member **422** and the second through-holes **592** in the cover **424**.

If desired, one or more resilient elements may be disposed between the light ring **38***a* and the gear case assembly **418** to generate or limit an axially directed clamping force that is exerted onto the light ring **38***a*. In the particular example provided, four resilient dampers **598** are mounted to second gear case member **422** and abut the front axial face of the light ring **38***a*. The resilient dampers **598** are compressed when the second gear case member **422** is fastened to the first gear case member **420** to thereby apply a clamping force to the light ring **38***a* that inhibits movement of the light ring **38***a* relative to the gear case assembly **418**.

With reference to FIGS. **27** through **29**, another driver constructed in accordance with the teachings of the present disclosure is generally indicated by reference numeral **600**. The driver **600** can be a drill/driver of the type that is disclosed in U.S. patent application Ser. No. 12/610,762 (the disclosure of which is incorporated as if fully set forth in detail herein), except that a lighting system is incorporated into the driver **600**. In the example provided, the lighting system **410***b* includes a first portion **610**, which can be mounted to an output spindle assembly **611**, and a second portion **612** that can be coupled for rotation with a drill chuck Cb.

The first portion **610** can comprise a set of spring contacts **620** that can be electrically coupled to a source of electrical power (e.g., to a battery pack via a trigger switch). The spring contacts **620** can comprise a first spring contact **620***a* and a second spring contact **620***b* that can be electrically isolated from one another. The first spring contact **620***a* can be offset in a radial direction by a first distance from a rotational axis **460***b* of the output spindle **406***b*, while the second spring contact **620***b* can be offset in a radial direction by a second distance that is different from the first distance.

The second portion **612** can comprise a sleeve **630**, a coupler **632**, a bushing **634**, a holder **140***b*, a circuit assembly **510***b*, a cover **636** and a retaining ring **638**. The sleeve **630** can be received about the chuck Cb and can be configured to receive a rotary input from an operator to open or close the jaws (not shown) of the chuck Cb. It will be appreciated that the chuck Cb can be any type of chuck Cb, such as a keyless chuck.

The coupler **632** can include an annular plate **640**, first and second conductor tracks **642** and **644**, respectively, and a plug **78***b*. The annular plate **640** can be formed of an electrically insulating material, such as a durable relatively non-conductive plastic (i.e., a plastic that is electrically insulating when an electrical potential that is less than 50 or 100 volts is applied to it). The annular plate **640** can be fixedly mounted on the spindle **650** of the chuck Cb. The spindle **650** of the chuck Cb can be engaged to the output spindle **406***b* by any desired means. In the particular example provided, the spindle **650** of the chuck Cb is threaded onto the output spindle **406***b* via left-handed threads and a spindle retaining fastener **652** is fitted through the spindle **650** and threadably engaged to the output spindle **406***b*. Accordingly, it will be appreciated that as the spindle **650** of the chuck Cb is coupled for rotation with the output spindle **406***b*, the annular plate **640** will also rotate with the output spindle **406***b* by virtue of its connection to the spindle **650** of the chuck Cb. The first and second conductor tracks **642** and **644** can be mounted to a first side of the annular plate **640** and can be disposed concentrically such that they are electrically isolated from one another. The first and second conductor tracks **642** and **644** can be configured to electrically engage the first and second spring contacts **620***a* and **620***b*, respectively. The plug **78***a* can be fixedly coupled to a second side of the annular plate **640** and can comprise terminals (not specifically shown) that can be electrically coupled to the first and second conductor tracks **642** and **644**. In the particular example provided, the terminals extend through the annular plate **640** so as to intersect respective portions of the first and second conductor tracks **642** and **644** and solder is employed to electrically couple the terminals and the first and second conductor tracks **642** and **644**.

The bushing **634** can be received between the spindle **650** of the chuck Cb and the sleeve **630** on a side of the chuck Cb opposite the annular plate **640**. A slot or groove **656** can be formed in the bushing **634**.

The holder **140***b* can be an annular structure that can define an annular trench **61***b*.

The circuit assembly **510***b* can include a circuit board **60***b*, a plurality of LED's **58***b* and a wire harness **550***b*. The circuit board **60***b* can be formed of an insulating material and can include wires or conductors (not specifically shown) that can electrically couple the wire harness **550***b* and the LED's **58***b*. In the particular example provided, the circuit board **60***b* is a printed circuit board that is formed in an annular shape that is configured to be received in the correspondingly shaped trench **61***b* formed in the holder **140***b*. The LED's **58***b* can be fixedly coupled to the circuit board **60***b* on a side opposite the holder **140***b*. The wire harness **550***b* can comprise a plurality of wires **76***b* including first and second wires (not specifically shown) that can be coupled to the conductors of the circuit board **60***b* and to the conductors (not specifically shown) in the plug **78***b* to transmit electrical power between the plug **78***b* and the LED's **58***b*. The wires **76***b* can be received in the radial space between the spindle **650** of the chuck Cb and the sleeve **630** and can extend longitudinally through the groove **656** in the bushing **634**.

The circuit assembly **510***b* can be coupled to the holder **140***b* in any desired manner, including adhesives, potting compounds, clips and fasteners. In the particular example provided, the holder **140***b* comprises a plurality of retaining tabs **560***b* that can extend through tab apertures (not specifically shown) in the circuit board **60***b*. The tabs **560***b* can be initially formed to extend in an axial direction that is generally parallel to the rotational axis **460***b* of the spindle **650** of the chuck Cb, which can facilitate the axial translation of the circuit board **60***b* into the trench **61***b*, and can be deformed in whole or in part to retain the circuit board **60***b* within the trench **61***b*. The tabs **560***b* can be deformed by twisting or bending, but in the example provided, each of the tabs **560***b* is heated and bent over at a right angle so as to lie over a portion of the circuit board **60***b* adjacent a corresponding one of the tab apertures.

The cover **636** can be an annular structure that can be fitted to an axial end of the sleeve **630** opposite the coupler **632** and can aid in axially fixing the holder **140***b* in place in the sleeve **630** against a front face of the bushing **634**. The cover **636** can be formed of a transparent material that can be clear or colored. The transparent material can be formed such that light received from the LED's **58***b* will exit the cover **636** in a desired manner. For example, the light exiting the cover **636** can be spread or concentrated over a desired area to illuminate one or more relatively large areas and/or one or more relatively small points.

The retaining ring **638** can be received in a ring groove **680** in the spindle **650** of the chuck Cb and can be configured to limit forward motion of the cover **636** relative to the sleeve **630** to thereby maintain the cover **636** on the spindle **650** of the chuck Cb.

With reference to FIGS. **30** through **32**, another driver constructed in accordance with the teachings of the present disclosure is generally indicated by reference numeral **800**. The driver **800** can be a drill driver of the type that is disclosed in U.S. patent application Ser. No. 12/610,762, except that a lighting system is incorporated into the tool. In the example provided, the lighting system **410***c* includes a generator **810**, a conductive connector **812**, an energy storage device **814** and a circuit assembly **510***c*.

The generator **810** can comprise one or more field windings **820** and one or more sets of magnets **822**. The field winding(s) **820** can be mounted on a generator shaft portion **826** of the output spindle **406***c* of the driver **800**. As will be appreciated from the aforementioned '762 patent application, the output spindle **406***c* can be coupled (e.g., via a spindle lock) to an output member of an output stage **830** of a multi-stage planetary transmission **404***c*. The generator shaft portion **826** of the output spindle **406***c* in this example can extend rearwardly of the output stage **830** to orient each field winding **820** with a component within the transmission **404***c* or driven by the transmission **404***c* that is configured to rotate at a speed that is higher than the rotational speed at which the output spindle **406***c* is driven. In the example provided, the generator shaft portion **826** extends rearwardly into a sun gear **832** that provides a rotary input to the output stage **830** of the transmission **404***c*. Each set of magnets **822** can be mounted to a rotating element of the transmission **404***c* (or an element rotated by the transmission **404***c*) and can be arranged concentrically about an associated field winding **820**. In the particular example provided, the set of magnets **822** is fixedly coupled to the sun gear **832** of the output stage **830** of the transmission **404***c*. It will be appreciated that during operation of the driver **800**, each set of magnets **822** will rotate at a speed that is higher than the rotational speed of its associated field winding **820** and that as a result of the speed differential, an electric current will be induced in the field winding(s) **820**. Stated another way, each set of magnets **822** and its associated field winding **820** comprise a generator that generates an electric current when rotary power is input to the transmission **404***c* during operation of the driver **800**.

The conductive connector **812** can be configured to electrically couple the generator **810** to the energy storage device **814** and/or to the circuit assembly **510***c*. In the example provided, the output spindle **406***c* has a hollow longitudinally-extending cavity **840** into which the conductive connector **812** is received. The conductive connector **812** can comprise a pair of wires that can be received through the cavity **840** such that the conductive connector **812** is mounted coaxially within the output spindle **406***c*.

The energy storage device **814** can be electrically coupled the generator **810** and the circuit assembly **510***c* in any desired manner and can be any type of energy storage device, including a rechargeable battery. In the particular example provided, the energy storage device **814** is a capacitor that is mounted in a chuck Cc that is coupled to the output spindle **406***c* for rotation therewith. It will be appreciated, however, that the energy storage device **814** could be mounted within the output spindle **406***c* in the alternative.

The circuit assembly **510***c* can be electrically coupled to the generator **810** and/or to the energy storage device **814** (e.g., via the conductive connector **812**) and can be mounted within the chuck Cc. The circuit assembly **510***c* can comprise one or more LED's **58***c* that can be driven by the electrical energy generated by the generator **810**.

While the generator **810** has been illustrated and described as including one or more field windings that mounted on an output spindle of a tool, it will be appreciated that the generator could be constructed somewhat differently. For example, the set of magnets **822'** can be mounted to a planet carrier **880** of a first planetary stage **882** while the field windings **820'** can be mounted to a planet carrier **884** of a second planetary stage **886** as shown in FIG. **33** such that the set of magnets **822'** rotate at a rotational speed that is higher than a rotational speed at which the field windings **820'** rotate.

In the examples of FIGS. **34** through **37**, the set of magnets is received within the field winding. In FIGS. **34** and **35**, the set of magnets **822"** is mounted on a drive shaft **900** that receives rotary power directly from a motor **402***c*" that drives the transmission **404***c*". The drive shaft **900** extends through the transmission **404***c*" and into the chuck Cc" such that a distal end of the drive shaft **900** is mounted coaxially within the field winding **820"** that is also housed in the chuck Cc". The set of magnets **822"** can be mounted to the distal end of the drive shaft **900**. With reference to FIGS. **35** and **36**, the set of magnets **822"** can comprise two or magnets that can be spaced apart axially along a portion of the distal end of the drive shaft **900**. In FIG. **37**, the drive shaft **900'"** is mounted to a component within the transmission **404***c*'" or that is driven by the transmission **404***c*'" so as to permit the drive shaft **900'"** to rotate at a speed that is higher than the rotational speed of the output spindle **406***c*. In the example illustrated, the drive shaft **900'"** is coupled for rotation with a planet carrier **910** associated with a second stage **912** of the transmission **404***c*'" that is intermediate input and output stages **914** and **916** of the transmission **404***c*'".

The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

What is claimed is:

1. A power tool comprising:

a housing

a motor received in the housing and coupled to a source of electrical power;

an output spindle extending from the housing;

a chuck external to the housing and coupled to the output spindle for rotational movement therewith;

a transmission configured to transmit rotational motion from the motor to the output spindle and to the chuck;

a light unit coupled to the chuck for rotational motion with the chuck;

a first electrical conductor connected to the source of electrical power and received in the housing;

a second electrical conductor connected to the light unit and received in the chuck,

wherein the first electrical conductor transmits power to the second electrical conductor to transmit power from the source of electrical power to the light unit.

2. The power tool of claim **1**, wherein the first electrical conductor remains substantially stationary in the housing.

3. The power tool of claim **2**, wherein the second electrical conductor rotates together with the chuck.

4. The power tool of claim **1** wherein the first conductor includes an electrically conductive contact, and the second conductor includes an electrically conductive track, such that the contact engages the track as the chuck rotates relative to the housing.

5. The power tool of claim 1, wherein the first conductor comprises at least one field winding.

6. The power tool of claim 1, wherein the first conductor further comprises at least one magnet, wherein the at least one field winding and the at least one magnet together comprise a generator of electrical power.

7. The power tool of claim 5, wherein the second conductor comprises at least one energy storage device.

8. The power tool of claim 1, wherein the second conductor comprises at least one field winding.

9. The power tool of claim 8, wherein the second conductor further comprises at least one magnet, wherein the at least one field winding and the at least one magnet together comprise a generator of electrical power.

10. The power tool of claim 1, wherein the light unit is mounted on a sleeve coupled to the chuck for rotation together with the chuck.

11. The power tool of claim 1, wherein the light unit comprises at least one lighting element received in the chuck.

12. The power tool of claim 11, wherein the light unit further comprises a printed circuit board, and the at least one lighting element comprises at least one LED mounted on the printed circuit board.

13. The power tool of claim 12, wherein the light unit further comprises a clear cover over the at least one LED.

14. A chuck for a power tool comprising:

a chuck body adapted to be non-rotationally attached to an output spindle of a power tool so that rotation of the output spindle causes rotation of the chuck body;

at least one field winding in the chuck body, the at least one field winding adapted to transmit electrical current;

a light unit coupled to the chuck body and adapted to illuminate an area in front of the chuck; and

a light unit circuit electrically connecting the at least one field winding to the light unit to transmit electrical current to the light unit.

15. The chuck of claim 14, further comprising at least one magnet received in the chuck body, wherein the at least one field winding and the at least one magnet together comprise a generator of electrical power.

16. The chuck of claim 14, wherein the light unit circuit comprises an electrical energy storage device.

17. The chuck of claim 16, wherein the energy storage device comprises a capacitor.

18. The chuck of claim 14, wherein the light unit is mounted on a sleeve coupled to the chuck for rotation together with the chuck.

19. The chuck of claim 14, wherein the light unit comprises a printed circuit board and at least one LED mounted on the printed circuit board.

20. The chuck of claim 19, wherein the light unit further comprises a clear cover over the at least one LED.

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